Instruments

THE MAGAZINE OF

Measurement and Control

Vol. 16
APRIL
1943
No. 4

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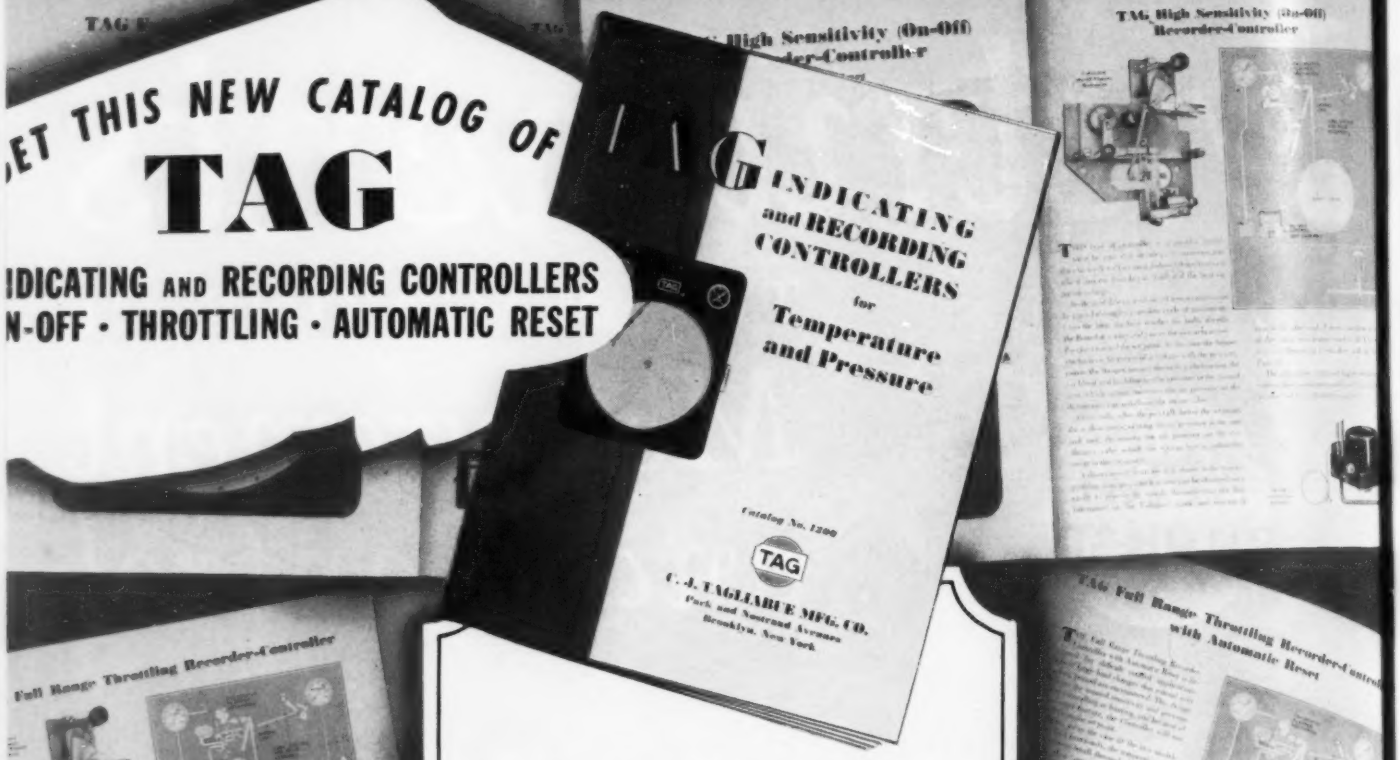

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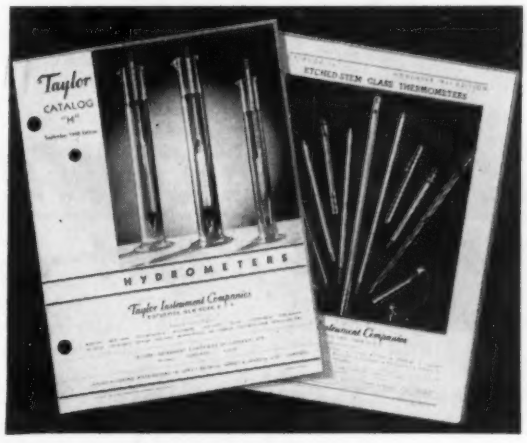

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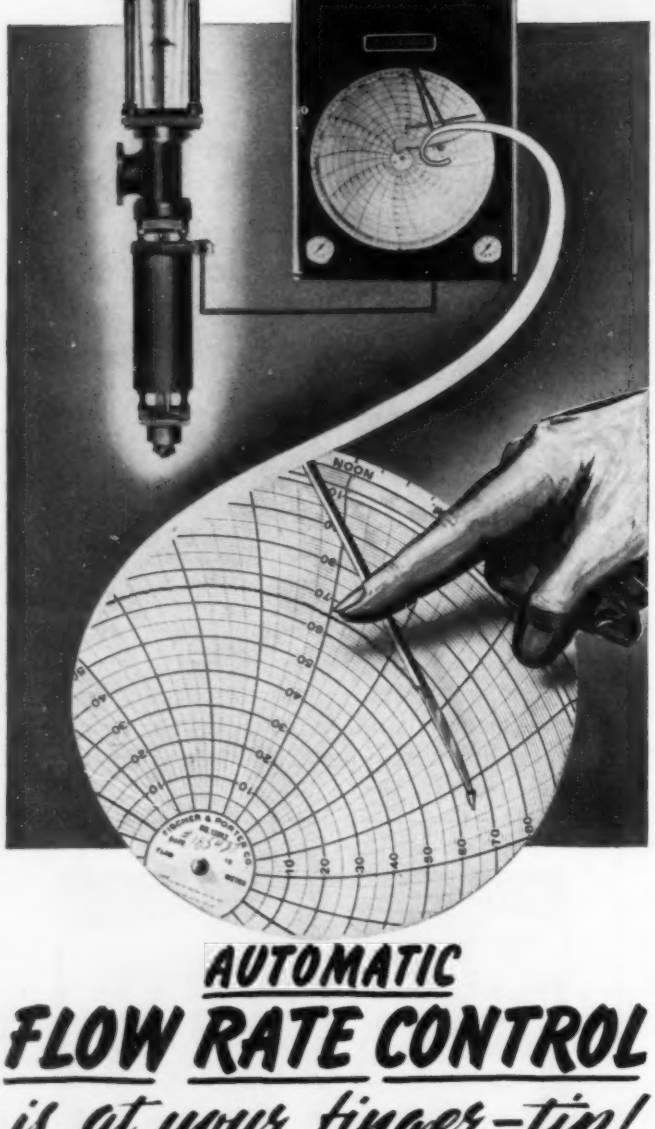

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F&P ROTAMETERS

Instruments

Vol. 16 APRIL 1943 No. 4

FRONT COVER:

"The enclosed photo is submitted for your front cover for three reasons: (1) It shows how an air line—the Chicago & Southern—teaches some instrument subjects to its non-technical employees; (2) It shows instrumentation for fuel consumption rate tests of Chicago & Southern Air Lines planes; (3) Guess the third reason when I ask you to be sure to return the photograph to me. —Larry Johnson, Burbank, Calif."

EDITORIALS 185
By M. F. Behar

ELECTRONICS AND IONICS 186
The first thorough definitions
By Joseph Slepian

GAGE CHECKING TRUCKS 188
Save time and gages in a war plant
By E. F. Keller

IMPEDANCE BRIDGE 189
With D-c. galvanometer
By Eugene Mittleman

ELECTRICAL INSTRUMENTS STANDARDIZED 190
The new A.S.A. C39.2
By M. F. Behar

War Production Serial

ORDNANCE PRODUCTION GAGING 192
Chapter IX on Gage Department Equipment
By Capt. R. A. Bowman, Ordnance Dep't

Aviation Instruments Department

FILLING THERMAL SYSTEMS 197
By Paul S. White

LOOP SIMULATOR FOR LINK TRAINER 198
By Hugh Davis

GYRO HORIZON CALIBRATION FIXTURE 200
By R. M. Torgerson

CHANGING GYRO AIR NOZZLE 200
By M. J. Wiggins

COAST TEST FIXTURE FOR GYRO 202
By R. M. Torgerson

AIRCRAFT INSTRUMENT GUILD:

Replacing Gear Teeth	G. Porter	204
Wheel Balancing Tool	L. H. Harvat	205
The Guild Q&A Column	E. M. Allsman	206

INSTRUMENTS IN THE WAR EFFORT 224-8

New Instruments Department 230
Indicators, recorders, controllers, inspection devices, for plant, field, aircraft and laboratory

INSTRUMENT SOCIETY NEWS 246
MANUFACTURERS' NEW LITERATURE 247
ADVERTISERS' INDEX 248

Published Monthly on the 15th by

THE INSTRUMENTS PUBLISHING COMPANY

1117 Wolfendale Street, Pittsburgh, Pa.

RICHARD RIMBACH, Publisher M. F. BEHAR, Editor

FIELD REPRESENTATIVES

Boston: James Condon, 36 Myrtle St. (Lafayette 0829). *New York:* R. K. Farnham, 545 Fifth Ave. (Murray Hill 2-4217). *Cincinnati:* Harold W. Haskett, Keith Bldg. (Main 4260). *Chicago:* Harold W. Haskett, Room 701, 360 N. Michigan Ave. (Franklin 5783). *Pacific Coast:* M. D. Pugh, 2989 Lincoln Ave., Altadena, Calif. (Sycamore 7-2894).

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Annual Subscription: U. S. $2.00. All other countries $7.00 *payable in advance* (remit by New York draft).

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Entered as second-class matter January 26, 1932, at the post office at Pittsburgh under the Act of March 3, 1879.

EDITORIAL COMMENT

Important Notice

EXTRACT FROM WPB L-24, March 26, 1943.

(a)(6) "Base period" means the year 1942.

(b) General restrictions. On and after January 1, 1943:

(1) No publisher shall use, or cause to be used for his account, print paper for the printing of his magazine or magazines, during any calendar quarter in excess of 22½% of the amount of print paper used by him or for his account, for such purpose, during the base period: Provided, That a publisher may, in any calendar quarter, use up to 15% more than his quarterly quota for such purpose, the excess to be deducted from the quota of the succeeding calendar quarter: And provided further, That a publisher may, in any calendar quarter, use additional print paper for such purpose equivalent to the less-than-quota usage of any preceding calendar quarters.

(c) Exceptions. The restrictions of paragraph (b) hereof shall not apply to any publisher who shall use, after March 31, 1943, 25 tons or less of print paper in any calendar quarter for the printing of his magazine or magazines, provided that no such publisher shall use, in any calendar quarter, more print paper than the larger of the following amounts (which in no event shall exceed 25 tons):

(1) The amount he used in the corresponding calendar quarter of 1942, or

(2) Twenty-five percent of the amount he used during the year 1942.

Any such publisher may (within the limitation of 25 tons or less of print paper in any calendar quarter), use in any calendar quarter additional print paper for the printing of his magazine or magazines equivalent to the less-than-quota use of any preceding calendar quarters.

UNDER this Amended Limitation Order the amount of paper which can be used by *Instruments* is further curtailed. We want to be sure that our old subscribers do not miss a single issue; and therefore ask you to read this carefully:

1. Send notices of changes of address as soon as possible—preferably before you move. Back copies can no longer be furnished.

2. Renew your subscription before it expires. If you do not remember the expiration date, look for it on the address stencil. Renewal notices will continue to be sent before expirations, but *only one notice* will be sent to each subscriber and renewal must be received within ten days.

3. Circulation of *Instruments* is limited to 10,000 copies. There already is a waiting list. Names on waiting list are placed on circulation list in regular order to replace non-renewals. In plain words this means that if your renewal is not received within ten days from mailing of renewal notice, your name is taken off; then, when your belated renewal comes in, your name is placed on the *waiting* list. On the average, one-twelfth of all subscriptions expire this month. If yours does, RENEW NOW.

4. No single copies will be sold.

5. No new foreign subscriptions can be accepted during the time that the WPB Limitation Order is in force.

How Are We Classified by Uncle Sam?

DESIRING to participate more actively in this "war of instruments" many subscribers wrote to ask how. All wanted assurance that their instrument skill would be used but every case seemed to be a special case. We could not devise a general formula; the more we studied the complexities of the situation, the more we despaired of being able to know the answers. However, as a result of all our clumsy attempts to be helpful, we slowly gleaned a few generally-applicable policies. We reported some in our July editorial; others in November, others in December. Since then, new manpower regulations were issued. Still more changes will be ordered as war needs grow more critical.

Currently, subscribers' occupational inquiries reflect some bewilderment over a fundamental question: If "this is a war of instruments," how does Uncle Sam classify us instrument men?

Selective-service classification cannot be the exact cause of bewilderment, because the exact question cannot be "how are all-of-us, taken as one group, classified?" The WMC will not segregate us instrument men *as instrument men* from the rest of our fellow-citizens as an occupational group in the same manner as physicians and clergymen.

In the first editorial we wrote after our appointment as your editor, we wrote

> We are all colleagues in one esteemed profession: All men who invent, design, build, sell, specify, apply, install, service and maintain measuring instruments, meters and automatic control equipment belong to one fraternity . . .

That was almost ten years ago. It is still basically true, but in the eyes of Uncle Sam we do not constitute one distinct, homogeneous group: we belong to various well-recognized groups such as Manufacturing (and its many subgroups), Public Utilities (several distinct classes), Research (many fields), Distribution and Service Industries, the Armed Forces, Education, and so on.

Various government agencies have divided instrument men or instrument skills or instrument businesses (or instruments) into a number of classes. No two agencies agree in their classifications, most of which are over-long, impossible to remember and difficult to apply. No agency seems to be aware of the tripartite classification (1) *Mechanical* (2) *Optical* (3) *Electrical*, which we thought "everybody" knew because we learnt it when we were an apprentice instrument-maker nearly forty years ago.

We instrument men no longer constitute two mutually exclusive groups: "makers" and "users," for the line which formerly divided instrument vendors from instrument purchasers is vanishing. Many "instrument companies" now make parts for guns, planes, ammunition, etc., in such volume that their instrument business is overshadowed. Many consumer-goods companies now make instruments and no longer make household or automobile or office appliances. But since modern production methods are impossible without instrumentation, we're all in the instrument-making AND in the instrument-using industries! It may almost be said that Uncle Sam classifies only the Armed Forces as "true" users of instruments and most of the rest of us as "makers." Unk's problem is *production.*

The only scientific government classification is that of the U. S. Employment Service, but it cuts across industrial boundaries and deals with classes of jobs, of skills, of aptitudes, etc. It works like magic in discovering the skills of people outside of instrument work and putting them into instrument work. It is of little help to our subscribers.

The WPB inherited a nightmarish set of classifications from the old OPM but several of its officials are experienced instrument men and it also enjoys the services of advisory committees made up of persons qualified to make sound recommendations. It is there, in the WPB, that Uncle Sam is most likely to establish useful classifications of instrument men as well as of instruments. We were one of those asked to recommend a simplified classification. Our two cents' worth of advice was: "Scrap those interminably long lists and complex organization charts; start all over again from the single classification: (1) mechanical, (2) optical and (3) electrical, which applies *equally* to instrument *men*, to instrument *skills* and to instrument *businesses*; and consolidate your numerous scattered instrument sub-sub-branches into three branches of one Instrument Division."

—MFB

Hail to the Army!

OLD subscribers may remember that several times since 1933 this page made an appeal for National Defense in April. That is because April 6 is Army Day and because your editor has been an Army Reserve officer since shortly after he returned from serving under Pershing. We usually boosted the Industrial Mobilization Plan and the Army Ordnance Association. We were not only criticized but threatened each time (especially when we wrote that Hitlerism aimed at the overthrow of Christianity, when we predicted that the U.S. would be attacked without warning or when we referred to "gangster nations") but we went right ahead. On this 1943 Army Day we recommend your reading the new edition of *The History of the United States Army* by Colonel William A. Ganoe (Appleton-Century, $5.00). Study what this greatest of living military historians writes about misguided Congressional and popular persecution of our armies not only between wars but during every war. It will open your eyes to Axis influences in our midst.

—MFB

Electronics

By JOSEPH SLEPIAN

ELECTRONICS, electronic engineering! These are words which fire the popular imagination today. Radio and television, the talking movie, the door-opening electric eye, the dentist's x-ray tube, the new fluorescent lamps, all these, evident in our daily lives, are said to be products of the science of electronics. The press and our electrical manufacturers hint of marvels accomplished in the war, the revolutionary devices to come after the war, all out of this science of electronics.

What is this science of electronics? Perhaps no exact answer can be given at this time. In technical or scientific literature a new word is given a sharp, precise meaning by definition of those who first use it, but a popular word may have initially only a vague meaning, which becomes more definite only after considerable usage. Gradually, and partly through discussions such as I am offering in this essay, a meaning emerges upon which most people will agree.

Consider a moderately-well educated young man, say one who has just come out of high school, and let us follow him in his explorations in trying to arrive at a good definition of the "science of electronics," or "electronics engineering." He has already met the electron. He knows that its existence was established by J. J. Thomson in the 1890's. He knows that it carries a negative charge of 4.77×10^{-10} electrostatic units, and has a mass only 1/1830th of the mass of the hydrogen atom. He knows, also, that its dynamics is quite different from that of bodies in everyday life, that it must be regarded as a wave, as well as a particle, and that a newly-developed "wave-mechanics" can describe its motions where the holder Newtonian mechanics fails.

His first impulse is perhaps to say that the "science of electronics" deals with those phenomena in which the electron enters, and that "electronics engineering" deals with apparatus or machines in which electrons play a necessary part. But he then immediately realizes that such a meaning is too comprehensive. He has learned that the electron is a part of every electrical manifestation of matter—and even of those manifestations which are not ordinarily thought of as electrical. He has come to believe that so common-place a matter as the conducting of a current by a metal wire is accomplished by the motion of tremendous numbers of electrons along the wire. With his first definition he would then be making the "science of electronics" and "electronics engineering" synonymous with "science of electricity" and "electrical engineering." He would be making an electric motor or an electric toaster "electronic apparatus."

He then feels the need of a drastic restriction in his definition, and perhaps proceeds next to examine a tube of his radio, which he is very sure is an "electronic apparatus." Such a tube has in it a hot filament from which electrons emerge, a highly evacuated space in which these electrons can move about under the influence of electric fields without encountering grosser matter, and various electrodes, grids and plate for creating the electric fields to cause the motion of these free electrons.

He is now ready to consider this definition: An "electronic apparatus" is one which accomplishes the purpose for which it was constructed, through the intermediary of electrons, relatively free from the grosser matter to which they are ordinarily bound. The "science of electronics" then, deals with *free electrons*, the means for setting them free, their motions when free, and the effects they can produce by being acted upon while free.

This definition seems quite good. Here are four examples of its application: (1) the free electrons in the *radio tube*, through the charges they carry, and the control the grids exert upon them, can change direct current into high-frequency alternating current, and vice-versa, so the radio tube is an "electronic apparatus." (2) The free electrons in the *x-ray tube* are accelerated to high kinetic energy, while free, and strike their target, producing Roentgen rays, so the x-ray tube is an "electronic apparatus." (3) Quanta of light arriving at the cathode of the *phototube* or "electric eye" set free electons to carry their charge to the anode, so the phototube is an "electronic apparatus." (4) Free electrons in the *fluorescent lamp* strike mercury atoms so violently that they are excited, and emit ultraviolet light, which in turn excites the material on the glass to fluorescence, so the fluorescent lamp is an "electronic apparatus."

But the young man looks again at the metal wire—and pauses. Do not the electrons in the wire move readily when acted upon by an electric field? Are they not, then, free? Again the electric motor and electric toaster intrude. Are they also "electronic apparatus"? He is back to his original dilemma.

Somehow, the young man feels, the electrons in the "electronic apparatus" are free in another

THERE is no doubt that electron tubes have made possible rapid advances in practical measurement and automatic control. There is no doubt that electron microscopes, cyclotrons and cathode-ray oscillographs are electronic instruments. There is some doubt as to the correctness of calling "electronic" any measuring instrument or automatic controller which uses one or more electron tubes instead of ordinary switches or hydraulic relays or pneumatic valves or magnetic relays or mechanical linkages or other servants of the non-electronic primary element—but it is commonly done. Justification: convenience, the same as the convenience of treating as one class all air-operated instruments; or all hydraulic-relay systems; or all a-c. servomotors. There is no doubt as to the INCORRECTNESS of calling "electronic" many electrical instruments and electromagnetic systems *entirely devoid of electronic devices*, but it is being done—in print, on the lecture platform and on the radio. We welcome, therefore, this authoritative and enlightening discussion of fundamental considerations.

Of possible interest in this connection is one of the definitions we received last October when, attempting to answer readers' questions, we queried various authorities. It came from the head of the Electronics Division of a world-famed company. Here it is: *"Electronics*—the art of exploring and applying that class of electric phenomena which arises from the fact that carriers of electric charge possess inertia."

What do *you* think? —M. F. Behar, *Editor*

and Ionics

Associate Director of Research,
Westinghouse Elec. & Mfg. Co.

sense and in another way than are the electrons in the metal wire. And by examining the modern theory of the atom and the modern theory of the electronic states of a metal, he begins to see how he may—and perhaps how he should—distinguish between the two kinds of freedom.

An isolated atom of an element in its normal state, he knows, according to Rutherford, Bohr, and their followers, has a positively charged nucleus surrounded by a swarm of electrons, and these electrons are in a kind of regular motion about the nucleus. Bohr regarded these electrons as moving in special radiationless orbits. But while moving in these orbits, and thus in a sense free, the electrons remain always close to the nucleus. Thus, they still remain *bound*. Impressed electric and magnetic fields will alter the motion of electrons about the nucleus, as is shown by the Stark and Zeeman effects. But the orbits are only shifted slightly or perturbed by the fields. They continue to surround the nucleus closely. The change in energy of the electrons with the largest attainable impressed fields is only a fraction of a volt, while their normal energies are many volts.

Dr. Slepian is not only a famous scientist, mathematician and engineer but an Instrumentician.

Now let two nuclei, with their accompanying swarms of electrons, approach each other. When about 10^{-8} cm. apart, the orbits of the outermost electrons begin to overlap. A new set of orbits forms, in which the outermost electrons now circulate around the two nuclei. Thus the outermost electrons have become free. Such an outer electron is no longer bound to a single nucleus, but can and does move from the neighborhood of one nucleus to the neighborhood of the other.

Now, by building up a chain of these nuclei, with their overlapping electron swarms, the young man in search of a definition of "electronic apparatus" begins to see what happens in a metal, and why a metal wire may not be an "electronic apparatus." In the metal wire the electrons become free only by being able to follow orbits which go from nucleus to nucleus. They are thus still bound in their freedom. They remain always within about 10^{-8} cm. from some nucleus.

The young man now triumphantly proposes his more refined definition of the "science of electronics." The "science of electronics" deals with electrons which are free in the sense of being substantially at much greater distances from the nuclei of atoms than the radii of the outermost stable orbits of the normal atom. That is, free electrons, in the sense developed here, are farther away from nuclei than many times 10^{-8} cm. In the usual radio tube, for example, the electrons in the vacuum space are generally more than 10^{-4} cm. away from any atom. They are free. In the metal wire, however, the conduction electrons are never more than a few times 10^{-8} cm. away from a nucleus. In spite of their mobility, they are not free in the sense used here.

The "science of electronics" is the science of these now sufficiently-well defined free electrons. It deals with the means for setting electrons free: thermionic emission, photoelectric effect, secondary emission, etc. It deals with the properties of free electrons, their motion in electric and magnetic fields, as in the electron microscope, their space charge effects, etc.

It deals with effects produced by free electrons acting on other matter, excitation, and ionization of atoms by collision, generation of x-rays, excitation of fluorescence, activation of a photographic film.

It deals with the ways free electrons lose their freedom, recombination with positive ions, attachment to neutral molecules to form negative ions, etc.

"Electronics engineering" is the applied "science of electronics." It deals with the development, design and application to useful purpose of electronic apparatus, that is, apparatus employing electrons free in the sense which has just been described.

The "free electrons" of an electronic apparatus must of course have space in which to exercise their freedom, so every electronic apparatus has in it a vacuum or gaseous space in which electric current is carried by free electrons. This is clear because in any liquid or solid element of a circuit the atoms or nuclei are too close together for electrons to be free as defined above.

This suggests a fully equivalent alternative definition of an "electronic apparatus." An "electronic apparatus" is *a device in which electric conduction current is carried through a vacuum or gaseous space*. This definition has the advantage of avoiding theory and referring only to objects which can be directly and immediately observed.

When we examine electronic devices, we find that they fall into *two rather definite classes:*

All employ free electrons, but some make important use also of positively charged atoms or molecules of the gas through which the electrons pass. These positively charged atoms or molecules are called IONS, so perhaps *Continued on page 210*

Truck System of Gage Checking Inaugurated

By E. F. KELLER
Factory Manager, Propeller Division, Nash-Kelvinator Corp., Detroit, Mich.

TO assure the accuracy and interchangeability of machined parts, all gages on production and inspection must be checked at least once each day. The purpose of inaugurating a system of truck checking was to simplify the control of the accuracy of gages at the points where they are actually used, thus obviating the necessity of transferring gages to and from the Master Gage Inspection Room for re-checking and also reducing the quantity of extra duplicate gages which would be required if this method of checking was not used. Not only has this purpose been achieved but an estimated daily saving of 200 man-hours results from the use of *each* truck. The plant served by this system has about 35,000 gages of about 5400 varieties. Needless to say, all gage trucks are in use 24 hours a day.

Each truck is equipped with all tools and measuring instruments needed to check gages on one certain line or area. On most trucks, this equipment consists of one set each of inside and outside micrometers from 1″ to 12″ with a complete set of standards, a surface plate, a 10″ height gage with 0.0001″ indicator, a comparator with 0.00005″ graduation, a set of precision gage blocks, a 12″ vernier, an angle plate, V-block, thickness feelers and parallels; also magnifying glass, scales, wrenches; hones, wax, alcohol torch, etc.

At this writing, five of these gage checking trucks are in use. They are saving **365,000** man-hours per year.

Each truck has a card file covering every gage used on the line or area covered: these cards must be kept up-to-date at all times with a complete historical record of each gage from the time it is placed in use until it is worn out or, in some cases, obsoleted. On this record card is noted all necessary information relative to gage and part numbers, also the findings of each daily check. If a gage is replaced by a new one a new card is issued and the same procedure followed. At the end of each shift, the truck is brought to the Master Gage Inspection Room where the equipment is checked before it is turned over to the checker on the following shift, as each checker is responsible for the truck and its equipment on his particular shift. If a checker has not been able to check all gages on his route, the checker on the following shift is notified and carries on from where the first man left off, thereby making a complete cycle of inspection of gages on the entire route. (If this routine were not followed and each shift began at the same starting-point, some gages would be checked several times and others not at all.)

To make certain that all checkers are familiar with the gages used on their respective routes, they are first trained by instructors who have made a thorough study of the gages—instructors who know from experience and training the necessary requirements of each gage. It can be readily seen that varied tolerances on machined parts make it necessary to hold certain gages to much closer wear allowances than others.

The equipment of a truck for checking thread gages differs, as it must include thread wires and supermicrometers as well as floating centers for use in conjunction with the supermicrometer: this allows the thread to center itself in relation to the axis and also takes the weight of the gage from the measuring anvils. The checker on this type of work has of course received special training.

As to the large fixture gages, the equipment on the trucks is not sufficient for this work and, therefore, these gages are checked against masters as in other plants.

As to methods of checking, mention may be made of the use of standard rolls in conjunction with gage blocks in the checking of snap gages: the roll is used as the moving unit of the build; it enables the checker to determine high and low spots of anvils as well as parallelism without sliding precious blocks.

The new system helps to control the accuracy of gages and to determine the points where gages receive the most wear. Checkers being specially experienced, they often instruct operators in the use and care of gages, thus reducing wear and increasing the life of gages: increasing the periods between reconditionings as well as the total service life.

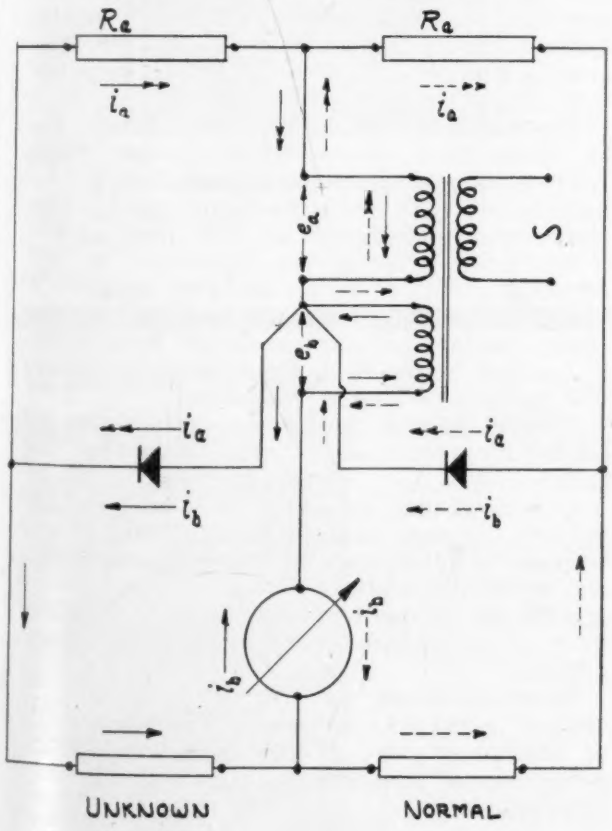
Impedance Bridge with D-c. Galvanometer

By EUGENE MITTELMANN
Consulting Engineer, Chicago, Ill.

VARIOUS attempts have been made to operate alternating-current bridges with direct-current galvanometers as zero balance indicators. The reason for the attempted substitution for the commonly used acoustical zero balance indicator is the physiological fact that it is easier to detect small differences by optical than by acoustical methods.

The ideal alternating-current bridge would be a construction as simple in design as, and having the sensitivity of a good direct-current bridge without further complicated accessories. A simple bridge using rectifiers in both branches of the bridge was described[3] by the author in an earlier publication. The drawback of this arrangement and, as a matter of fact, of all similar arrangements using rectifiers either in the zero branch or in an auxiliary branch, is the fact that when approaching balance conditions, the rectifiers are working on the curved part of their square law current-voltage characteristic corresponding to minimum sensitivity of the rectifier cells. Thus, at the very point where maximum sensitivity of indication is desired, the highly increased resistance of the rectifiers prevents obtaining a sharp balance position.

A bridge circuit which overcomes these difficulties is shown in the accompanying diagram. The bridge is formed by the unknown impedance to be measured, the normal, and two selenium or copper oxide type rectifiers. The indicating device, a direct-current galvanometer, is in series with the external voltage e_b, which is supplied by a transformer. The indicating device passes currents i_b in opposite directions in each half-cycle of a full period. The arrows drawn in full indicate the currents in the period between 0 and 180 degrees. The arrows drawn with dashed lines correspond to the currents flowing in the second half period between 180 and 360 degrees. Only if the unknown and the normal are equal, will the magnitude of the currents in both half-periods be the same and result in an average mean value of zero. (Sinusoidal currents are assumed.)



For the purpose mentioned in the foregoing paragraph, namely to shift the operating point of the rectifiers towards the part of their characteristic with the steepest slope, an auxiliary voltage e_a is required. This auxiliary voltage must not affect the current through the indicating instrument. The auxiliary voltage e_a is obtained from a second winding of the same number of turns as the other secondary but in opposite direction. When the windings e_b and e_a are carefully balanced (equal and opposite in phase), no potential difference will exist between the outer terminals of the two windings. Hence no additional current will flow through the galvanometer. In other words, the galvanometer remains unaffected by the presence of the voltage e_a, as far as the balance is concerned. The additional voltage e_a will drive a current i_a through the rectifier, the magnitude of which is determined by the value of the auxiliary resistances R_a. The double arrows in full and dashed lines correspond again to the first and second half-period, respectively. The value of i_a is suitably chosen to correspond to the maximum slope of the rectifier.

The bridge as described above performs not only in a similar way to a direct-current bridge in that the deflection of the galvanometer indicates the direction of deviation from the balance position, but in addition it is phase-sensitive. The auxiliary resistances R_a are pure ohmic resistances and hence the mean values of the current through the galvanometer will depend upon the phase relation between the auxiliary current and the currents in the branches, including the unknown and the normal respectively. Depending upon this phase relation, the time during which the current i_b is flowing simultaneously with the maximum sensitivity of the rectifier will be different for various phase angles of the unknown and the normal respectively. Therefore, equal values of the mean currents can only result in both half-periods if the phase angles of both normal and unknown are identical as well as the values of their resistances equal. In other words, their impedances must be equal.

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First Comprehensive American Standard on Electrical Instruments is Promulgated

By M. F. BEHAR
Editor, *Instruments*, Pittsburgh, Pa.

INSTRUMENT history was made a few weeks ago when there was issued the first Standard covering not only the testing but the actual design and construction of instruments. It is the "American War Standard C39.2-1943, Electrical Indicating Instruments (2½-and 3½-Inch Round, Flush-Mounting, Panel-Type)." It was approved on January 8 and printed by the American Standards Association in the form of a 48-page paper-bound brochure 7¾" × 10¾" with two columns of type to the page—nearly equivalent to 48 pages of *Instruments*. We do not know the exact date when this historic document came off the press but we received our first copy on March 16 and immediately hastened to prepare this article. Note that this is merely an article *about* this Standard—not a condensation. Readers engaged in or connected with the design and manufacture of panel-type electrical indicating instruments, or of equipment using such instruments, are urged to buy copies of the document, at 50 cents each, from the American Standards Association, 29 W. 39th St., New York City.* This article is chiefly intended for the other *Instruments* readers—who naturally constitute the large majority—and its purpose is not so much to reproduce any text but rather to chronicle the event fittingly.

The ".2" after "C39" implies that there was a C39.1. There was—a 20-page standard on electrical indicating instruments—but it was mostly definitions and tests; it standardized no instruments.

C39.2 is different: it is comprehensive!

This standard was prepared for the purpose of facilitating production of electrical indicating instruments. It was prepared through the coördinated efforts of representatives of industry and of the Armed Services at the request of the War Production Board. R. B. Shepard, Chief of the Simplification Branch of the Conservation Division of the War Production Board, headed the ASA War Committee on Electrical Indicating Instruments.

Performance requirements, test methods, standard dimensions and standard ranges for a standard series of 2½" and 3½" round flush-mounting panel-type instruments (of the high quality required by the Armed Services) are incorporated in C39.2 in such a form as to be used directly for the procurement of these instruments by the Armed Services. Lack of interchangeability of these instruments has caused a serious problem for Army and Navy supply branches. Meanwhile, instrument producers have been hampered by numerous orders for instruments which are basically the same but vary in small details of external design. Dimensions set in the new standard will assure interchangeability of instruments of all manufacturers, thus easing up the problem of supply. It will also render unnecessary the maintenance of the present large stocks of spare instruments in the repair depots of the Army and of the Navy, which are scattered from Iceland to the islands of the South Pacific.

The standard series of instruments covered by C39.2 includes only those with molded cases. This should cause no difficulty when it is understood that simple lightweight metal shields can be designed for those cases requiring electrical shielding.

It is expected that C39.2 will be used by the Armed Services in the design of new equipment and that, insofar as is practicable, replacement instruments will be based on these standards. Other sizes and shapes of panel-type electrical indicating instruments now in use by the Armed Services are not covered by C39.2. It is not intended that their manufacture be immediately discontinued.

Now that this standard is in print, it should be controlling in the preparation of new manufacturing facilities for panel-type electrical indicating instruments.

Designers of equipment in which or on which panel-type instruments are used should likewise go by this standard as extensively as possible in order that maximum production may be had with a minimum waste of time and material. Instructions to equipment designers are given, especially as regards dimensions.

As a result of the ASA War Committee's work, various laboratories are engaging in research on the effect of high temperature and high humidity on miniature instruments, on the effect of vibration and shock on these instruments, and on the question of high-frequency error in miniature radiofrequency instruments. Results of this research will be written into future revisions of C39.2 or into separate standards.

The standard form of letters and figures (based on Army-Navy Aeronautical Design Standard AND-10400 and appearing on page 28) is the only specification with which the writer could find fault: these letters and figures are like those made with a round-nib lettering pen, free-hand or with a celluloid guide cut by an inexpert designer. This "face" is not only uglier but less legible than already-standardized medium-Gothic faces approved by various better-sight committees. We believe it will be more difficult to reproduce.

Without finding "faults" we can add that a few qualitative requirements could be made quantitative.

Outside of this, we are proud to add our humble voice to the many that are hailing C39.2 as a masterpiece of joint work by representatives of dissimilar groups united by patriotism and functioning like an all-star team. To "coach" or "captain" Shepard, and to his co-workers, our hearty congratulations!

Whoever thinks we are unduly playing up a "minor" event does not realize how many millions of instruments are affected and how sizeable a percentage of American industry's man-hours will be saved.

Continued on page 216

*As usual, of course, copies are available without charge, for procurement purposes only, from the government agency concerned.

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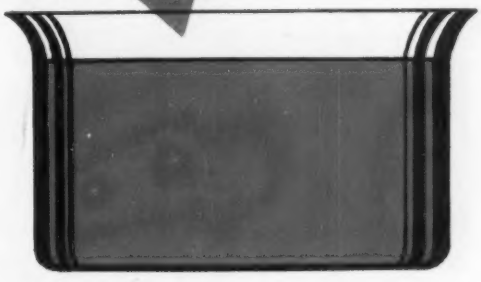

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Ordnance Production Gaging

By CAPTAIN RUSH A. BOWMAN
In charge of Pittsburgh Gage Laboratory, Ordnance Department, U. S. Army

CHAPTER IX

THE GAGE DEPARTMENT OR LABORATORY: ITS EQUIPMENT

Proper equipment is a prime requisite for the proper inspection of gages. In the establishment of a department or laboratory (sometimes called the Standards Room, Master Gage Inspection Room, etc.) for the inspection of a manufacturing company's production gages, certain tools, instruments and other equipment are essential and certain others provide refinements for labor-saving purposes. It is to be borne in mind that labor-saving in the sense of time-saving to speed deliveries is extremely important. In any case, of course, the completeness and the nature of the equipment will be dictated by the types of gages to be inspected. Below is a list of the *minimum* equipment to inspect the gages involved in *the average small-part machine shop production* such as shells, fuzes, small arms, etc. Cost being a factor in the establishment of a laboratory, approximate prices are given (in round numbers only, for convenience in estimating total first costs of various combinations).

Group I

Gage Blocks:	
81-block Set with accessories	$450
28-block Set (thin)	300

Group II

Master Cylindrical Square	125

Group III

Comparator (with divisions of 0.00005″ or 0.000025″)	600
Supermicrometer (0.0001″)	450
Measuring Machine (0.00001″)	5000

[EDITOR'S NOTE—The "minimum equipment" might be one, two or all three, or two of one type, or even three of one type only, depending on numerous factors, chiefly the kind of large-quantity production in which the plant is engaged. For a plant producing aircraft gyro components and other closest-tolerance A&N items, a measuring machine might be the selected type and simple arithmetic might show that one measuring machine operated 24 hours a day would not be sufficient. Read carefully Capt. Bowman's text under "Group III."—M.F.B.]

Group IV

Micrometers:	
Hand, external, to 3″	$ 35
Hand, internal, 2″-8″	10
Hand, depth, to 6″	15

Group V

Surface plate (one is minimum):	
Iron, 18″ × 24″	75
Iron, 24″ × 36″	150
Glass, 18″ × 24″	40
Glass, 24″ × 36″	75

Group VI

Indicators:	
One 0.001″	22
One 0.0005″	25
One 0.0001″	25

Group VII

Surface Gage	6
Vernier Height Gage	100

Group VIII

Taper Parallels, set,	20
Small Hole Gages, set,	7
Telescoping Gages, set,	15

Group IX

Parallels, pair,	12
Angle Plates, each,	30
Parallel Blocks, each,	50

Group X

Rolls:	
0.100″, pair,	10
0.200″, pair,	10
0.250″, pair,	10
0.500″, pair,	10
Wires, Thread Checking, set,	10-12

[A "set" comprises three wires for checking the threads of thread gages of only one particular pitch. A "complete set of wires" or "complete assortment" would comprise twenty to twenty-four sets of three wires each, for checking threads from 80-pitch to 4-pitch, and would cost approximately $200. See Capt. Bowman's text under "Group X" in next month's instalment.]

Group XI

Sine Block	40
Sine Bar, 10″	40

Group XII

Optical Comparator	750 to 5000

Group XIII

Straight Edges	
One 6″	7
One 12″ (or 15″)	11
Precision Squares:	
One 2″ × 3″	5
One 4″ × 6″	8

It will be noted that the above list is divided into groups based upon types of equipment. In some groups, notably Group III, there is a choice as to the particular tool or instrument. All thirteen groups, however, should be represented in the equipment of the laboratory.

[EDITOR'S NOTE—At the risk of starting arguments, mention must be made of the school of thought which maintains that a high-grade fully-equipped optical comparator (Group XII) has so many uses outside of gage inspection, and is used so easily and quickly, that the cost of the first one purchased by a plant should be charged against Production and not on the Gage Laboratory budget—even though it is installed in the laboratory and maintained by laboratory personnel.—M.F.B.]

In the following sections there will be discussed in detail the considerations affecting the choice of any particular tool or instrument for the laboratory. Not only will the types of equipment be described but the degree of care or "expertness" required for each type will also be mentioned briefly because it may affect the decisions.*

GROUP I

Gage Blocks

There is no substitute for gage blocks in the laboratory. They are the laboratory standards of length measurement. They also provide the laboratory standard for parallelism.

Gage blocks are commercially manufactured in two designs: the "USA" design (Fig. 1) and the "Hoke" design (Fig. 2).

*Care and maintenance, as a subject in itself, will be dealt with in the next chapter. It may be stated here, however, that highly-trained personnel must be available from the start.

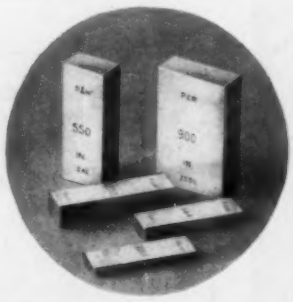

Fig. 1. Showing the appearance of the "USA" design gage blocks.

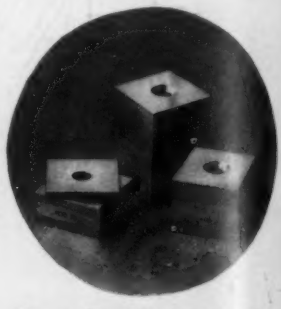

Fig. 2. Showing the appearance of the "Hoke" design gage blocks.

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Yes, for both today's production needs and for post-war product planning, experienced engineers are designing to use Sylphon Bellows and Bellows assemblies, as pressure diaphragms, expansion joints, shock dampeners, thermostat members, expansion chambers, dustguards, packless valves, flexible seals, etc., etc.

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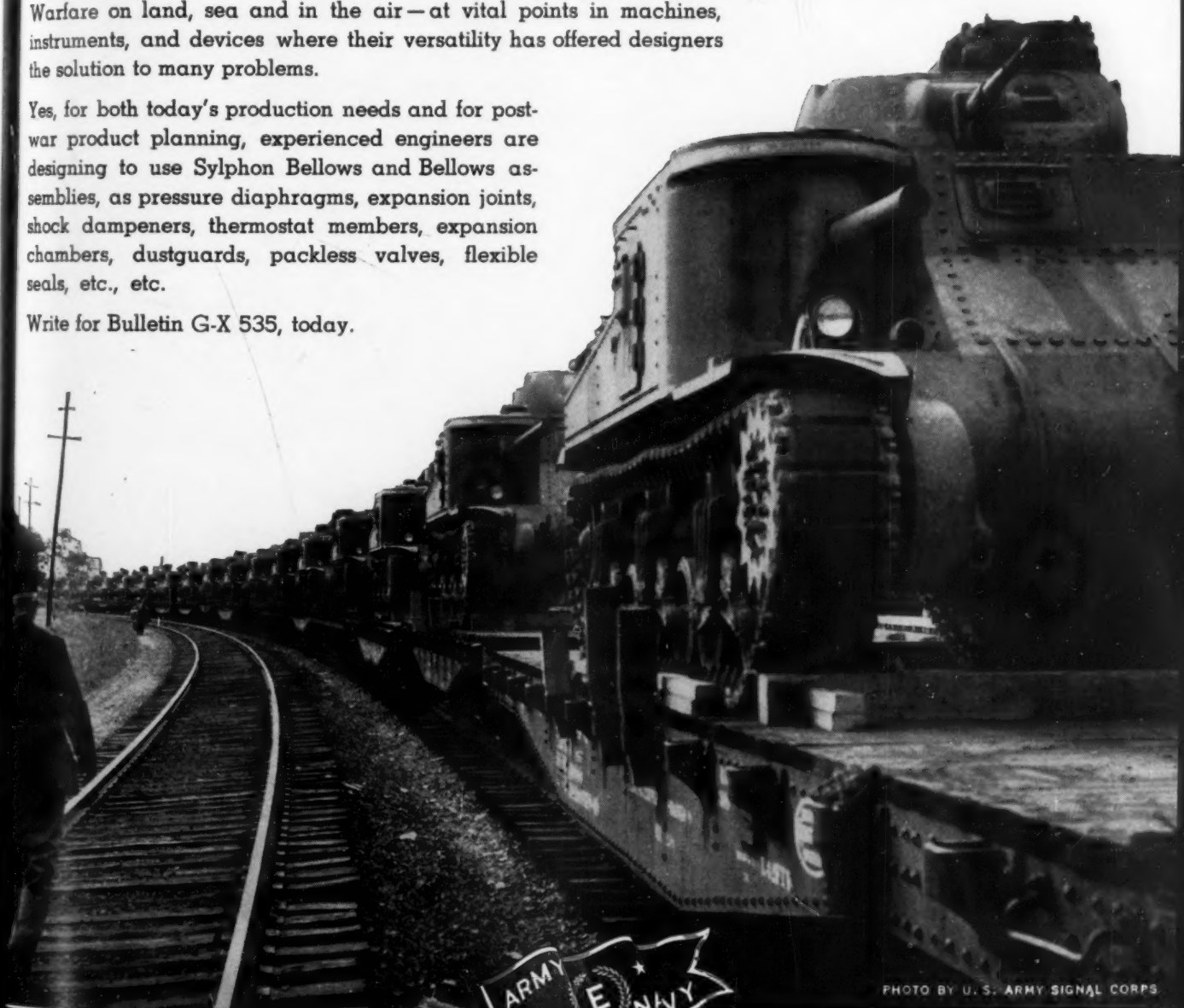

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ARMY E NAVY

THE FULTON SYLPHON CO.

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Representatives in All Principal Cities in U. S. A. and in Montreal, Canada and London, England

Fig. 3. An 81-block set of "USA" design blocks as manufactured by the Johansson Div. of the Ford Motor Co.

This unique serial is based on the remarkably successful course of lectures by Captain Bowman (then Lieutenant) to us Reserve Officers, in which he combined the fruits of his civilian experience as Gage Supervisor and of his Ordnance training.

—M. F. Behar, *Editor*

Gage blocks are normally divided into three classifications as to accuracy. Specifications depend upon the company, but generally a laboratory set is accurate to ± 0.000002″ (two millionths of an inch) per inch of length, the standard set to ± 0.000005″ per inch of length and the working or shop set to ± 0.000008″ per inch of length.

In addition, gage blocks are normally classified by their range of sizes. The set most commonly in use contains 81 blocks, which gives the widest range of possible sizes in ten-thousandths of an inch. See Fig. 3. The effective range of sizes is from 0.200″ to over 8″. Occasionally, a set of 40 blocks is used to cover the same effective range. However, difficulty is often encountered in attempting to build more than one set of blocks for a particular size as is often necessary in the case of flush pins or where three-point suspension is desired.

A set containing 28 "thin" blocks is also manufactured for the set-up of sizes below 0.200″. See Fig. 4.

The 81-block set and the 28-block set should be accompanied by gage accessories. In the case of the "USA" standard design as manufactured by Johansson, Pratt & Whitney, Webber, Savage, Dearborn and others (see Fig. 3), accessories normally come separate. In the case of Pratt &Whitney "Hoke" design blocks, the accessories come with the 81-block set and are "standard equipment" in the carrying case. See Fig. 5. Accessories generally include scribers, half rolls, V's, straight-edges, etc., which are indispensable in the small laboratory where the purchase of other laboratory accessories such as standard rolls may not be economically feasible.

These two sets, the 81 and the 28, together with accessories, are indispensable.

One other set, known as the "long-block set," Fig. 6, is sometimes used in connection with the 81 and 28 sets where a wider range by ten-thousands is desired above 8″. This set generally contains eight blocks between 4″ and 20″.

Fig. 4. A 28-block set of "thin" blocks, "Hoke" design, as manufactured by Pratt & Whitney.

Fig. 5. An 81-block set of "Hoke" design blocks with accessories, as manufactured by Pratt & Whitney.

CHAPTERS PREVIOUSLY PUBLISHED. I. Interchangeability — Sept. '41 and May '42; II. Inside Dimension Gaging—July '42; III. Outside Dimension Gaging—Aug. '42; IV. Offset Dimension Gaging—Sept. '42; V. Position and Alignment Gaging—Oct. '42; VII. Profile Determinations—Dec. '42; VIII. Thread Gaging—Feb. '43; VI. Taper and Angle Determinations—Mar. '43.

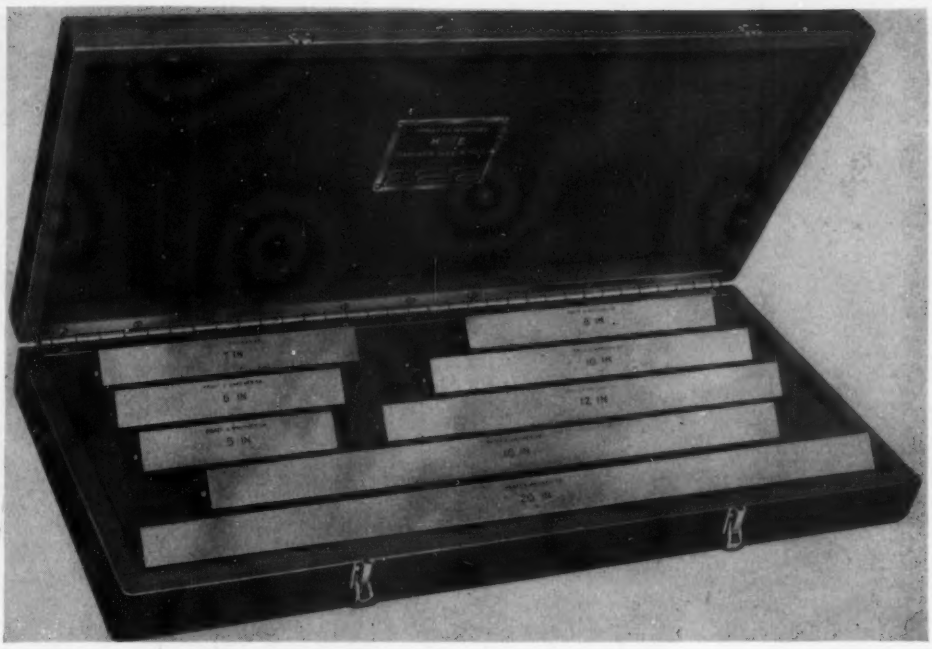

Fig. 6. An 8-block set of "long" blocks, "Hoke" design, as manufactured by Pratt & Whitney.

Special Care of Gage Blocks—The surface of a gage block is of such hardness and finish that it may be wrung with another block (see Fig. 7) or master flat "a number of times" without measurably affecting size but it is obvious that "a few" surface molecules or crystals are disturbed each time. Experience has shown that 240 wringings result in a wear of eight millionths of an inch. One method used in some shops and laboratories to minimize wear on the set as a whole is to maintain, for instance, several 0.100" blocks. When a measurement is to be made, these blocks are wrung to each end of the build-up in such a manner that *the same side* of the 0.100" block is always in contact with gage blocks, while the other side is always in contact with the surface plate, snap gage anvils, comparator anvils, comparator points, etc. This not only reduces wear on the set, but if a scratch should occur on one surface, it is not likely that this surface would be wrung to any other gage block with the possibility of scratching that block. If scratches occur, they then occur on only one side each of two blocks and are not transmitted to other blocks in the set.

Gage blocks should not be wrung together for periods longer than an hour or two, as corrosion is likely to take place. Nobody knows just why, but it is a fact.

Gage blocks should be periodically calibrated. *It does not matter what the size of a gage block is, so long as we know what it is.*

When thin blocks are used, particular care should be taken with respect to temperature changes. Thin blocks take up the heat of the hand more rapidly than blocks over 0.200" and will change size faster. Whenever possible, a single thin block should not be used alone. Either two thin blocks or, preferably, one thin block and one block from the 81 set, should be used, because the body of the thin block is not able to maintain its shape against internal stresses—as is apparent if a thin block is laid lightly on a table under an optical flat: it will show poor flatness. The same block,

Continued on page 214

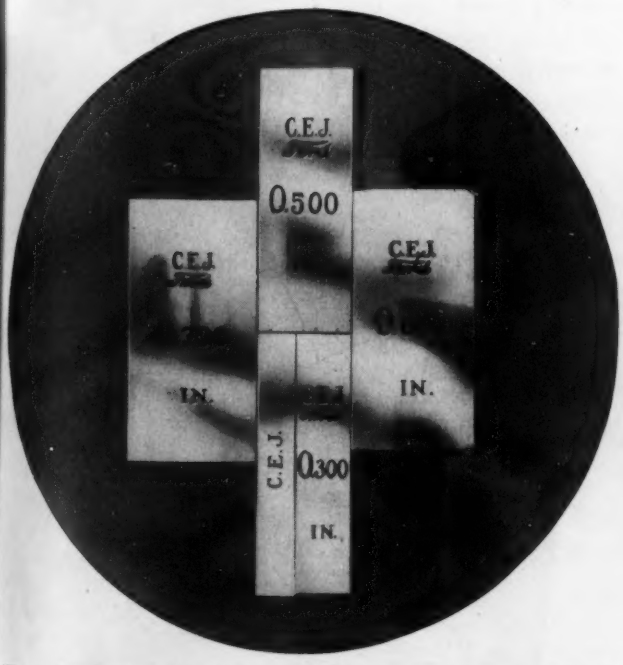

Fig. 7. Illustrating the wringing of gage blocks. Note that one 0.300" plus one 0.200" are equal to one 0.500" block within wringing tolerance (several millionths of an inch).

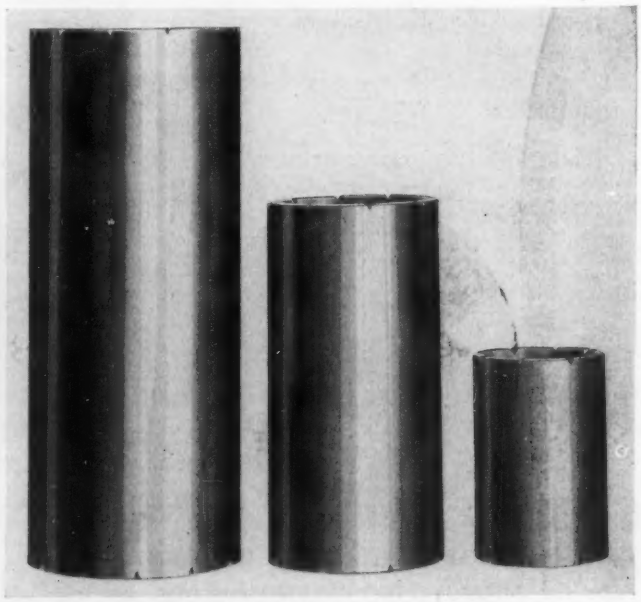

Fig. 8. Three sizes of cylindrical squares as manufactured by Taft-Pierce Mfg. Co.

"COMPARED TO THIS OCEAN-HOPPING, flying a transport over the Blue Ridge was duck soup. All you did then was hang onto a beam. But, brother, it's different now. There aren't many signposts on the way to Africa except the dials on your instrument panel. And when there's nothing in sight but salt water, those dials are mighty comforting.

"After the war, I guess I'll be back behind the wheel of a passenger plane again but I'll probably still be flying by instruments . . . in the stratosphere . . . non-stop from coast-to-coast. Well — as long as I've got instruments I can depend on, I'll say that's the way to get there."

WHAT TOMORROW'S PLANES *will look like or how they will perform, we don't exactly know. But we do know that Kollsman research engineers are constantly planning and developing new and better precision aircraft instruments . . . to help smooth out tomorrow's skyways, and give safer wings to a nation at peace.*

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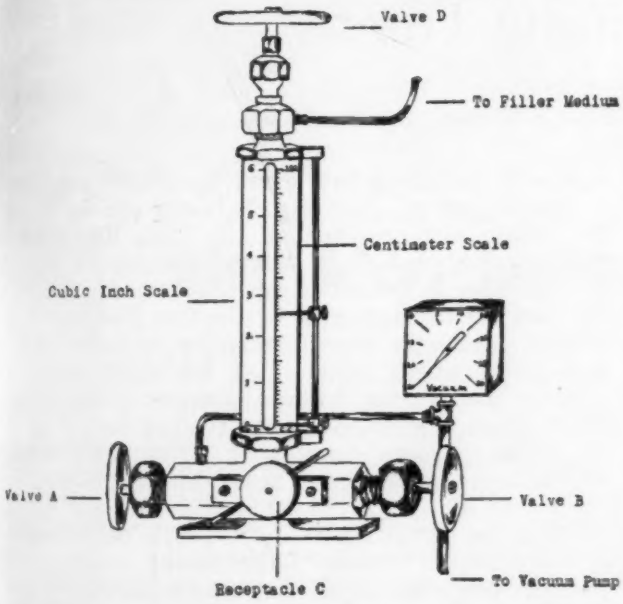
Vol. II, No. 4 M. F. Behar, Editor APRIL 1943

Pre-calibration Filling of Remote-reading Thermometer Systems

By PAUL S. WHITE
2214 Main Street, La Crosse, Wisconsin

IN treating remote-reading thermometers for calibration, a prime requisite is the proper quantity of filler medium introduced through the capillary and the correct length of the Bourdon tube ascertained beforehand, so as to expedite the mechanical calibration adjustment. It will be easily seen that by obtaining the correct quantity of filler liquid the thermometer may be, after proper filling, nearly on calibration. This will greatly facilitate handling of the Bourdon tube end-piece or adjustment segment.



The sketch shows an ingenious filler mechanism for aircraft thermometers used by a large aircraft manufacturer for quantity production with a minimum of handling.

The filling medium tank is suspended above the operator; the system uses gravity feed. The gage glass is calibrated in cubic centimeters with a sliding scale for zero adjustment, as it is of vast importance to determine beforehand the exact quantity of liquid for the varied sizes and lengths of capillary used. Directly underneath the filler is a small vacuum pump for evacuating the capillary.

After blowing out the tubing with high-pressure air and baking it to remove all moisture, it is soldered into the bulb and head respectively with proper precautions taken to insure pressure-tight fittings and clean connections.

The filler tube is inserted into receptacle *C* which is easily sealed by tightening the thumb adjustment with valve *B* closed and valves *A* and *D* open. The gage glass is filled with liquid to the proper amount as determined on the scale. At the same time, by having valve *A* open, which connects with the vacuum pump, the capillary is being evacuated. The line now being ready for filling, valves *A* and *D* are closed and *B* is opened, at the same time immersing the capillary line and bulb in cracked ice to facilitate the filling operation.

The liquid flows into the line and, by observing the gage glass, the proper amount of filling is assured. After the above operation, the filler tube is released by loosening the thumb adjustment, at the same time allowing a small amount of the filler liquid to escape momentarily for assurance that no air will be retained in the capillary. The tube is then pinched and brazed, and the instrument is ready for calibration.

By following the proper procedure, it will be found that with due care exercised in filling, the instrument will scarcely need adjustment for calibration, and in a great many cases merely setting the pointer on zero will suffice.

Filling has proven to be a production bottleneck in many instances and, as has been noticed on numerous occasions, proper care results in a *better* instrument because it is not handled to excess which might tend to shorten its life.

No Guest Editor this month—and no assurance that all those scheduled for the remainder of 1943 will be able to fulfill their commitments. Pressure of war work is the reason. There's a silver lining to this cloud, however, and it is that some of these outstanding aviation instrumentation educators, while asking to be relieved from full charge of one issue of this Department, promise to contribute exclusive articles which will appear *sooner* than the scheduled Guest Editorship months. —MFB

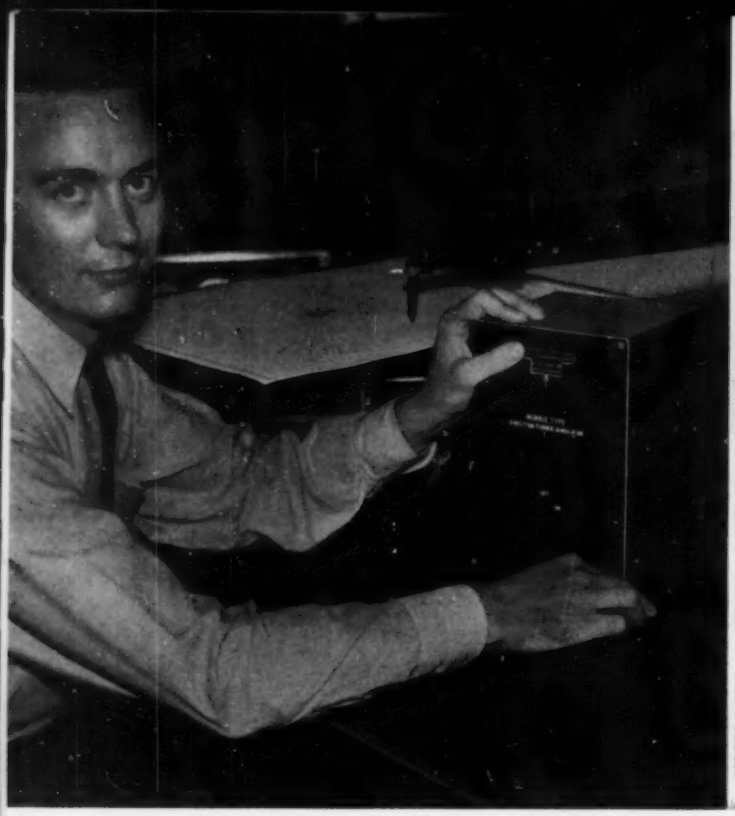


Fig. 1. Cecil Morris at the control box of the direction-finding loop simulator.

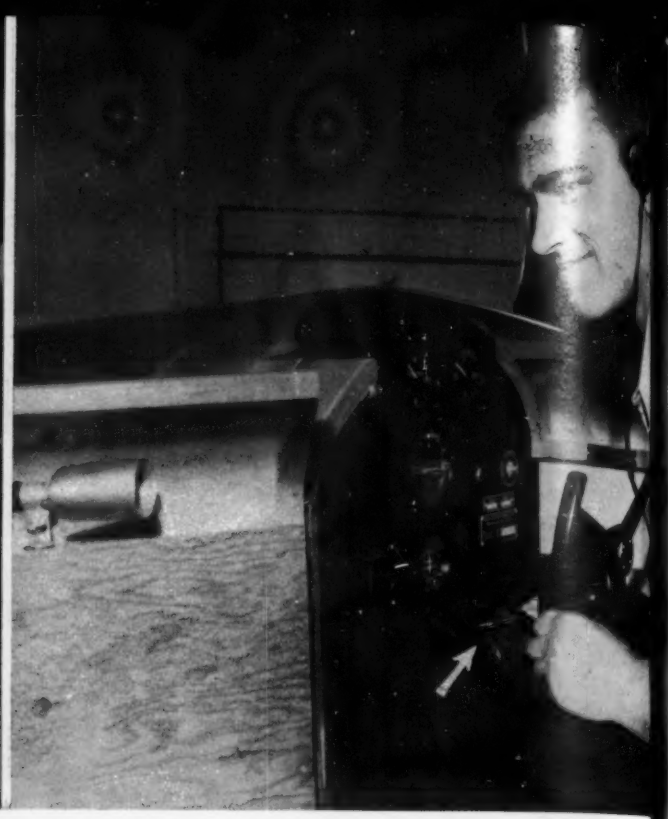


Fig. 2. Bob Mitchel in a Link cockpit. Arrow points to simulated Sperry direction finder.

Automatic Loop Simulator for Link Trainer Halves Training Time

By HUGH DAVIS

Chief Instrument Flight Instructor, Transcontinental & Western Air, Inc., Kansas City, Mo.

TWO members of the TWA Instrument Flight Instruction Department, Cecil Morris and Bob Mitchel, have developed an automatic loop simulator for Link trainers which accurately simulates the Sperry automatic direction finder. This device, called the Morris Type Direction Finder Simulator, makes it possible to train pilots in the use of the Sperry unit on the ground in approximately one-half the time formerly required in the air. Now in use in the TWA flight training section, the automatic loop simulator consists of two units: a control box located on the operator's desk; and the head, mounted in the Link trainer, which closely resembles the regular Sperry Automatic Direction Finder head. This head consists of two azimuth scales, one mounted inside of the other and rotatable. This makes it possible to keep the magnetic heading of the aircraft constantly under the zero on the outer scale. A needle on the head is attached to the shaft of an Autosyn receiver mounted on the under side of the head and controlled from the control box. The control box has an azimuth scale, which is seen through a small window, quite similar to a directional gyro. A knurled disk is used by the operator to set the scale at the desired reading. (See Fig. 1.) Inside the control box are the transmitting Autosyn, a resistor and suitable sliprings and contacts.

The Morris Type Direction Finder Simulator is used with a special chart. This chart is a compass rose with radiating lines every five degrees marked in the reciprocal. (See Fig. 1, background.) When the inking pen or wheel of the Link Recorder is moving over the chart, all that is necessary for the operator to do is to keep the scale on the control box set to the degree of the line the pen is on at that particular time (interpolating between the five-degree lines). Now if at the same time the pilot in the trainer keeps the inner scale of the head which is mounted in the trainer (see Fig. 2) set to the magnetic heading he is flying, the needle will indicate on the inner scale the magnetic bearing to the station, or in other words the magnetic heading he would have to fly (with no wind) to arrive over the station. This type of chart can be used for any station; all that is necessary to change stations is to give the pilot a different chart to be used in the cockpit.

Chief advantages of the new direction finder simulator are: it can be used with any type of recorder or wind machine; the operator knows to the degree what reading the pilot has on the inner scale (provided, of course, that he is using it correctly); it is simple and comfortable for the operator to use; easy to install; no additional sliprings are required on the trainer; the operator can learn to operate in a day's time.

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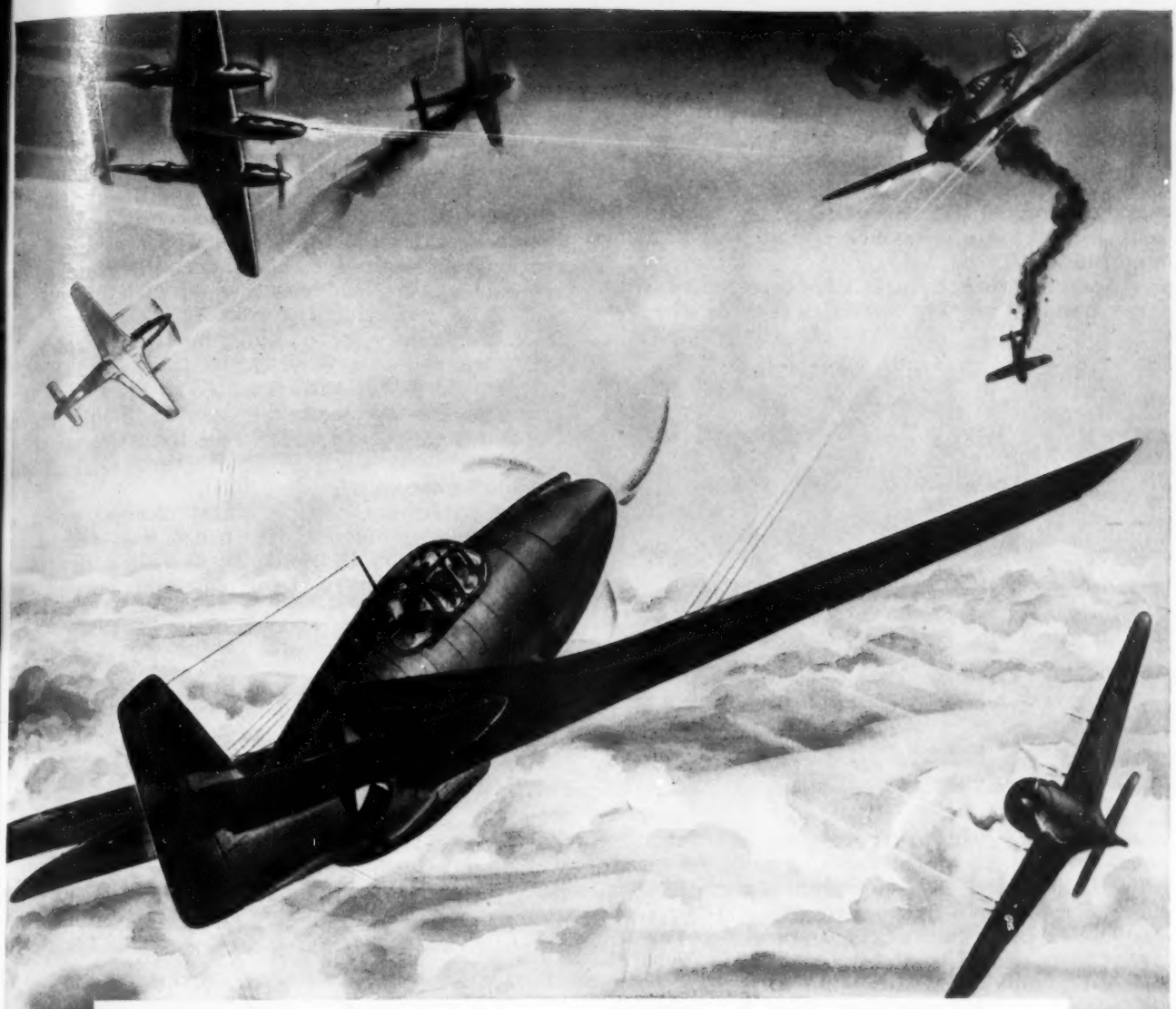

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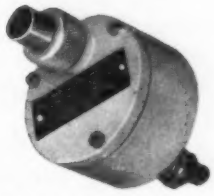

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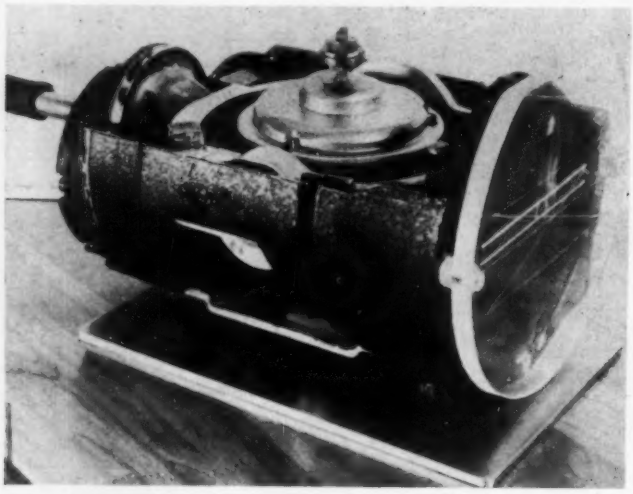
Gyro Horizon Outside Calibration Fixture

By ROLAND M. TORGERSON
Head of Dep't of Gyroscopic Instruments,
Naval Air Technical Training Center, Chicago, Ill.

CERTAIN equipment needed for the overhaul of gyroscopic instruments being impossible to obtain, several fixtures have been built from available materials.

By careful work, fixtures were constructed which have been in use for several weeks by the men



studying Sperry aircraft gyroscopic instruments at the Naval Air Technical Training Center, Chicago.

In the picture it is obvious that the gyro horizon outside calibration fixture was made from a discarded gyro instrument case. The case has been cut away to facilitate easy handling of the gyro element. The air filter housing was turned on a metal lathe, and the base was made from ¼" sheet iron. The dial was made from plexiglass and has proven to be an extremely useful addition.

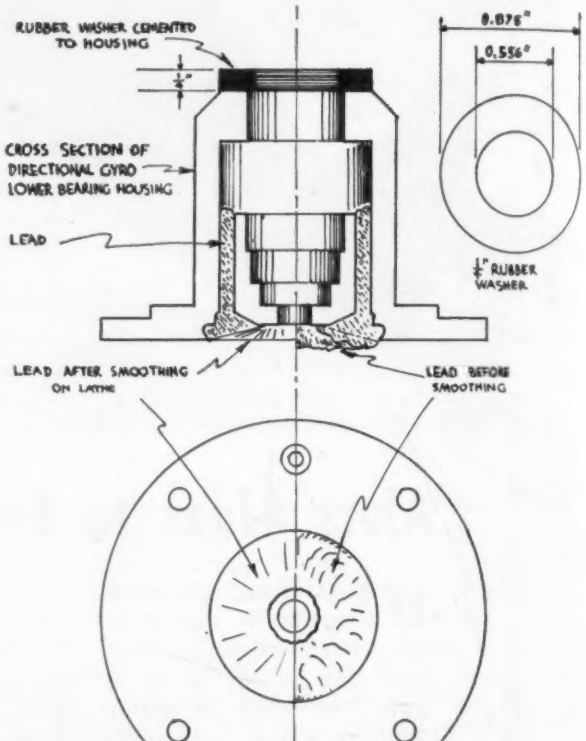
Cleaning the Directional Gyro Air Nozzle

By M. J. WIGGINS
1373 Cumberland Road, Jacksonville, Florida

IN the overhaul of the Directional Gyro, a few extra minutes spent in insuring that the air nozzle passages are perfectly clean will often save hours in calibration. This instrument is extremely sensitive to the adjustment and condition of the air nozzle. A thousandth of an inch change in the position of the nozzle will result in a great effect on the drift of the instrument in final calibration. Therefore, it can readily be seen that trouble will be encountered in calibration if the nozzle passages are restricted in any way as any dirt or foreign matter will distort the air stream. Often the drifts will be erratic and time will be lost attempting to calibrate. The following tips have proven effective in quickly and efficiently cleaning the air nozzle and may be helpful to others.

A special fixture which can be easily made has worked very nicely. Its construction utilizes a discarded lower bearing housing from a Directional Gyro. First, the air screen is removed and the thrust ball support is driven out with a drift punch, which also drives out the races, balls and retainer. These parts are discarded. The housing is then cleaned and placed on the bench, bottom up. Melted lead is then poured around the air passages in such a manner that the holes fill up. The lead should be allowed to spread completely around the air screen recess with the exception of the center hole. Care should be exercised to keep this opening clear. If a neat job is desired the housing can be chucked in the lathe and the lead smoothed off with the cutting tool. If no lead is handy, ordinary sealing wax will do a satisfactory job of plugging the air holes. A ¼" thick rubber washer 0.875" diameter, 0.556" hole, should be cut and cemented to the top of the housing. The accompanying sketch should make the above operations clear. This fixture is used to blow out the air passages in the vertical ring and air nozzle as will be described.

The nozzle openings are first cleaned using a pipe cleaner dampened with benzol (or whichever cleaning solution is used), then with a dry pipe cleaner. Insert the vertical ring air pivot in the



fixture described above and hold in upright position. Drop benzol in air nozzle holes with an eye dropper until full. Rock the vertical ring slightly while dong this. Then blow high-pressure air through the hole in the bottom of the fixture. Practically all dirt in the passages will be blown out. This can be seen by the blackened benzol which will be sprayed on the top of the vertical ring! Of course, this is washed off. The procedure can be repeated if necessary. Finally, run the dry pipe cleaner through the air holes and again blow out with the high-pressure air. Inspect the openings in the nozzle with the loupe and very carefully remove any burrs that may be present using a small

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jeweler's graver. This procedure is applicable to either single-hole or double-hole nozzles.

Before assembling the vertical ring, center the nozzle with the longitudinal axis by running the long upper pivot from the case into the 90° gimbal pivot hole. Adjust the nozzle screw until the pivot will enter the small hole in the back of the nozzle perfectly. Remove the pivot. Little trouble should now be encountered in nozzle adjustment during calibration.

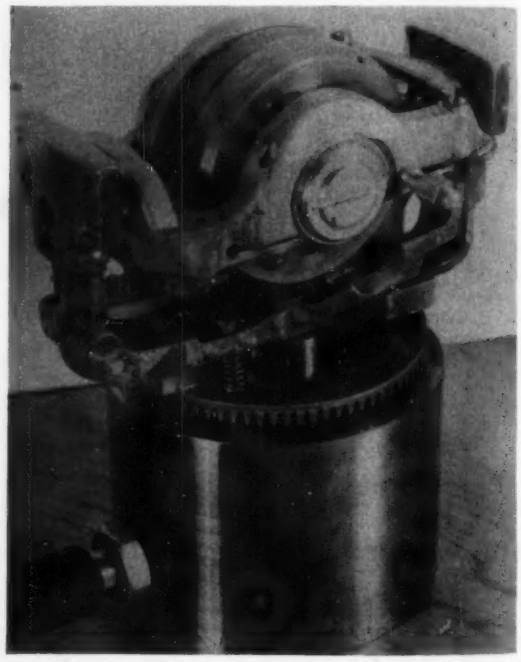
A Coast Test Fixture for the Directional Gyroscope

By ROLAND M. TORGERSON

Head of Dep't of Gyroscopic Instruments, Naval Air Technical Training Center, Chicago, Ill.

IT was found desirable to have several portable coast test fixtures in the classroom to enable the student to work at his own desk and to make the necessary corrections on his instrument.

The fixtures were constructed from discarded vertical rings. The complete vertical ring assembly is used without alteration except that the top part of the vertical ring is cut off about half an inch



above the horizontal pivots. This makes it easier to install the gimbal ring and rotor assembly.

The base is made of mild steel 2¾" in diameter and 2¼" high. Turn a projection on the top of the base ⅜" high and 1" in diameter. A hole is drilled in the top of the projection the exact size of the vertical outer ring or lower pivot housing and then a connecting hole is drilled in the side of the base for the hose fitting. Before installing the vertical ring, the lower bearing pivot must be removed. The vertical ring is more securely fastened by screws through the gear into the base.

The position of the nozzle need not be changed. The centralizing lever spring is adjusted so that the centralizing lever will hold the rotor in a level position.

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The following articles (to the bottom of Page 208) have been contributed by the Aircraft Instrument Guild. For further information on any of the subjects discussed, write to the Guild at the above address.

Replacing Broken Gear Teeth

By GEORGE PORTER

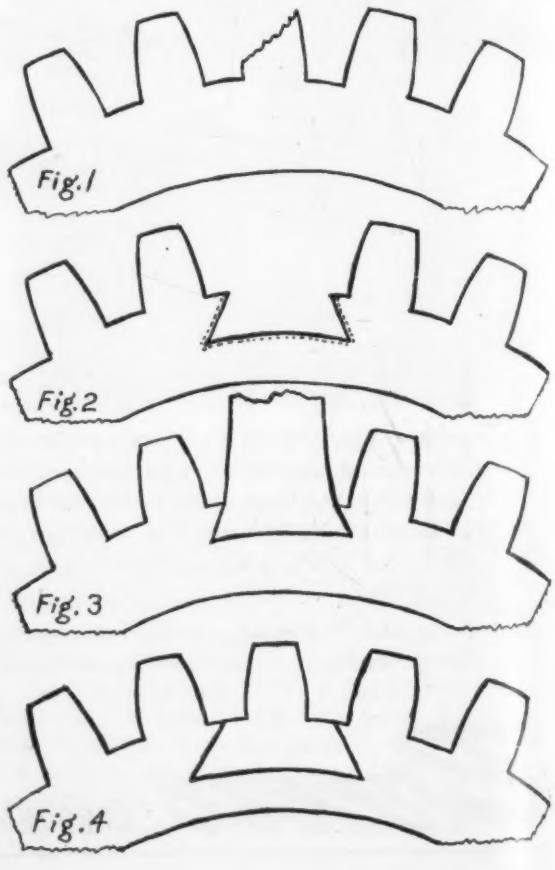
Guild Mechanic, Spartan School, Instrument Overhaul Dept.

SHORTAGES of spare parts—especially the trouble in obtaining brass and other alloy wheels—make it necessary to do many little repair jobs on broken parts. When gear teeth are broken and new wheels are not available, badly-needed instruments may be grounded unless there is some way of making repairs. The following method has proved practical and is a simple job for any mechanic, once he learns the procedure.

When the wheel has a fairly heavy rim, the job is not as ticklish as if it were for example an altimeter idler gear where great care must be taken, not only to prevent the wheels from stretching, but also to make the teeth as perfect as possible.

A section is cut out of the wheel beneath the broken tooth (see Fig. 2) using a fine-cutting jeweler's saw. The section must be made slightly larger than the base of the tooth or teeth to be replaced and, as the cut is made deeper, the section being cut out must be larger. The section therefore will be larger at the base than at the top.

Then a piece is cut to fit in the opening and enough material left to enable a tooth to be filed out of the top part, Fig. 3. If the piece to be replaced is left slightly thicker



than the wheel, it is an easy matter to taper slightly the edges of the cut made in the wheel so that the edges of the piece being placed in the wheel may be slightly peened out over the bevel. Then the piece may be lapped down to the same thickness as the wheel. Now the wheel may be etched or left with the grey finish as desired.

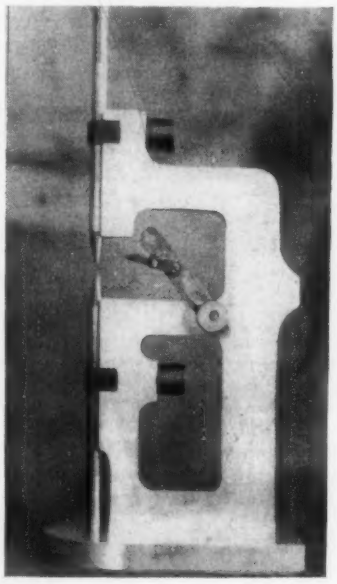
The next step is to file the tooth (or teeth). Care must be taken not to get the tooth too thin and not to damage the tooth next to it. If the tooth is brought close to shape before it is placed in the wheel, there will be less danger of injuring the teeth next to it. This will also help to keep the addendum, dedendum, clearance and diametral pitch within tolerances. If a file with a burnish back is not readily available, one may be easily made by grinding the back side off a regular small flat file, rounding the edges on the back side.

The correct width or chordal thickness of the tooth may be estimated by rolling the depthing wheel or pinion across the section first in one direction then the other, noting the spacing of the contacting teeth, especially at the pitch diameter, filing a little at a time off of the new tooth until the tooth ahead of it is just in contact with its corresponding depthing tooth. This will also get the tooth properly spaced and give it the proper curve keeping the pressure angle uniform. If the job is carefully done, the new tooth will not only work perfectly but also defy detection. Fig. 4.

A Handy Tool for Truing or Balancing Wheels

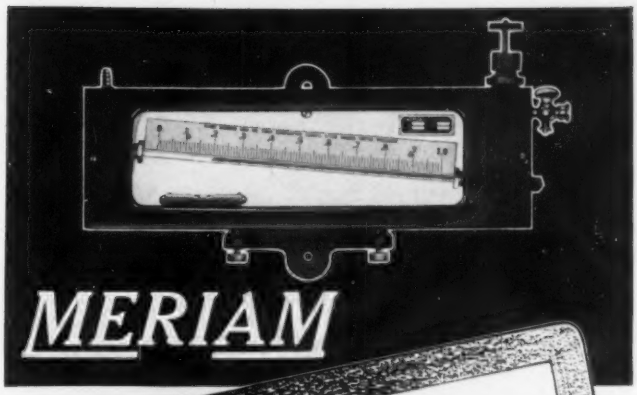
By L. H. HARVAT
Spartan School of Aeronautics, Tulsa, Okla.

THIS jig, made from a K&D watchmakers' truing caliper of the bench type, is widely useful to the instrument mechanic because any staking tool punch will fit the caliper and may be used as centers, pivots or bearings in truing wheels, especially for sensitive altimeters and other instruments of that type. It is especially adaptable for truing



hairsprings on the staffs in the flat and round, and has enabled the writer to reduce his time in the repair of instruments. The closing punches work best on sensitive altimeters where one has fine pivots and must true on the shoulders of the pivots. Wheels with hole bearings can be trued on centers, while those with heavy pivots can use the regular flat end hole punches.

Another advantage is that the punches can be set at any distance apart, as may be required for the truing of different types of wheels. The truing guide is adjustable to any position desired for truing. It may be used for balancing of sector gears, hands, etc., having jig in horizontal posi-



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tion. Note the extension on the back of jig. This acts as a leg when used in a horizontal position.

This tool may be made without too much difficulty. The one in the picture was made by a student with the help of an instructor.

The A.I.G. Q&A Column

Conducted by EVERETT M. ALLSMAN,
Recorder, Aircraft Instrument Guild, Tulsa, Okla.

Q. *"R. B." (Montana) writes that he has been experiencing considerable difficulty with a vacuum installation and requests a general rule for installing vacuum lines.*

A. Although there are four possible sources of subatmospheric pressure in aircraft (vacuum pump, Venturi, intake manifold and carburetor) we shall assume that the most satisfactory—an engine-driven pump—is being used, with one of the others serving as alternate source.

The line leading from the pump to the instrument panel should be relatively large, never less than ⅜" in diameter and free of sharp bends or angles. For large installations greater diameter tubing should be used. One system relief valve should be installed as close to the instruments as possible, followed by a check valve if an alternate source of subatmospheric pressure is provided.

In branching the line to the turn indicator, flight indicator and turn-and-bank indicator, care should be taken to maintain the size of the tubing, especially with regards to the first two and precaution exercised as to sharp bends. A needle restrictor or vacuum-regulator throttling valve, preferably of the adjustable type, should be installed in the line in the immediate vicinity of the turn-and-bank to control the vacuum within the case. A flexible connection should be used at each instrument.

A standard suction gage will now be connected through a vacuum gage selector valve to the flight indicator and turn-and-bank by means of ¼" tubing. If the selector valve is not available, connect the suction gage directly to the flight indicator.

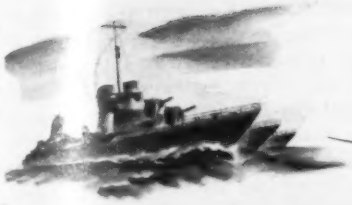
Following installation, the system relief valve may be set to 4" of mercury and the turn-and-bank restrictor or regulator valve adjusted to 1.9" of mercury differential pressure while the plane is on the ground. However, to assure satisfactory operation it is necessary that a flight test be given. This is particularly true of the turn-and-bank indicator by reason of individual instrument characteristics and varying temperatures.

As regards the particular trouble which R. B. experienced with the turn-and-bank, it is suggested that he take special note of temperature.

Q. *"J. W." (Georgia) wants to know why some fuel pressure gages have two vents while others have only one and if there is any connection therein with scale range.*

A. Most of the newer fuel pressure gages are equipped with two rear vents and they may be used with either externally or internally supercharged engines. The instrument is, of course, intended to measure the differential pressure between fuel and air at the carburetor inlets. Consequently, when used with an internally supercharged engine the vent marked "air" will be open to atmospheric pressure. Some installations require a connection to the static tube as air enters the induction system at this pressure. However, in the instance of a turbo type supercharged engine, air is being packed into the carburetor Venturi at a pressure greater than atmospheric and it is therefor necessary to vent this greater pressure to the inside of the instrument case, around the Bourdon tube, if we are to measure the correct differential. Naturally, this requires that the fuel pressure gage have an air-tight seal, which makes it quite obvious why the fuel pressure gage of an engine gage unit cannot be used with an externally supercharged engine such as found in the B-24.

The above has no connection with scale range, there being



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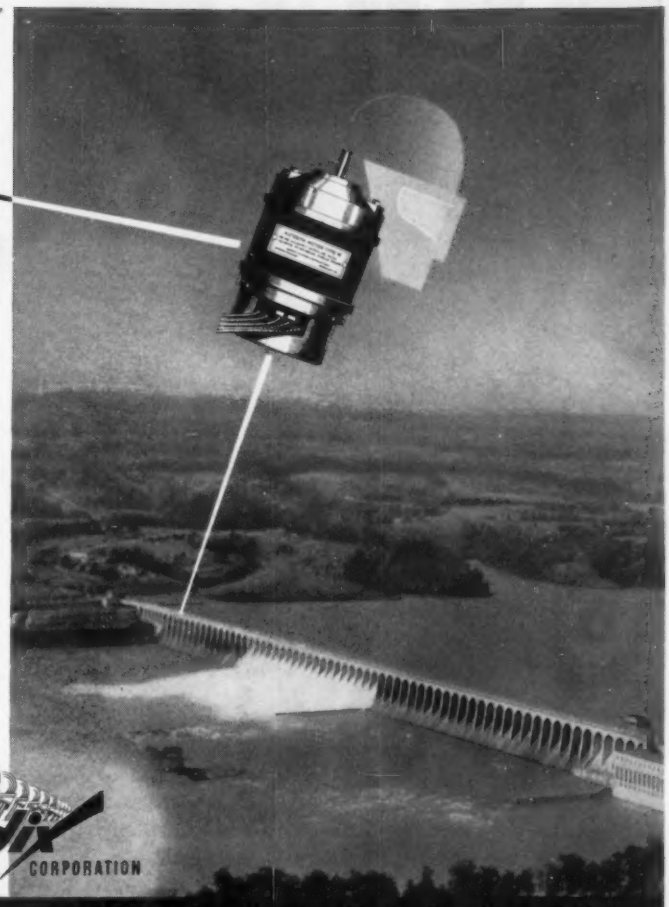

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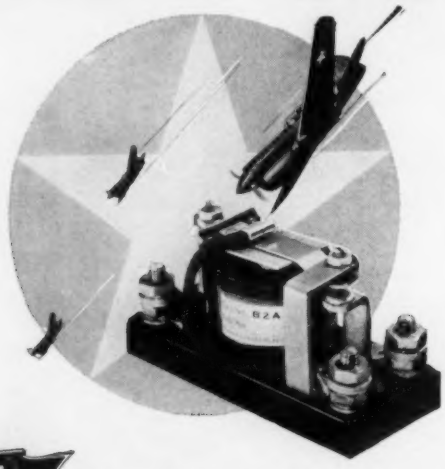

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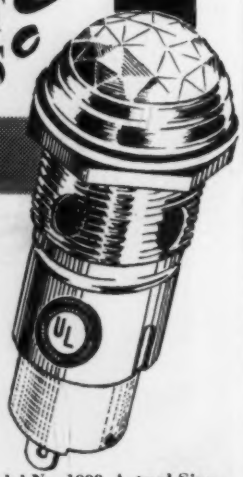

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two types under this classification, i.e., 0-10 and 0-25 lbs./in.^{2}. The first is used with conventional type carburetors which might be found with either external or internal type superchargers and it has an operating range of approximately 3 to 5 lbs. Pressure discharge type carburetors require a fuel pressure gage range of 0 to 25 lbs. and usually operate at 13 to 15 lbs. Naturally the latter type includes the smaller scale range and could be used in either instance.

Q. "E. E." (Texas) writes: "We are experiencing considerable difficulty with mechanical tachometer installations in our primary training planes. Can you offer any suggestions?"

A. Judging from the wording of the request, I presume that the fault lies in the installation and not within the instrument itself. We can expect much of our trouble from the fact that the mechanical tachometer is driven by a flexible drive shaft connected to the accessory drive of the engine. This shaft must of course be properly inspected and lubricated at the time of installation, the next 50-hour inspection and each engine change thereafter. Since these are probably Army planes, grease 295, Specification No. 3560, medium, should be used unless temperatures are extremely low, in which case petrolatum may be used. To accomplish periodic inspections, it is necessary to remove the inner shaft from the flexible housing. Closely inspect both units: if either is abnormally worn it should be replaced. Lubricate and reinstall with few bends and no bends of radius less than 6". Remember that excessive pull (over 15 lbs.) can damage the core or housing. Extreme care should be exercised in checking the length of the core in relation to the housing. If core length exceeds the specified tolerance by ⅛", the resulting drive-shaft friction may lead to instrument failure or set up a corrosive action which coats the inside of the case. Installed in the plane with either tang in place, the second tang should protrude from 9/16" to 1¼". If the result is not within this tolerance, adjustment may normally be made by carefully twisting the housing clockwise or counter-clockwise. Adjustment is usually necessary by reason of bends. The crew chief or mechanic must never neglect to install the retaining washer correctly over the male tang at the accessory end of the drive-shaft as failure to do so results in excessive wear of the flexible core and tangs. Worn or loosened tangs may be replaced or tightened as they are held in place by means of soft solder whereas a damaged or broken core may not be repaired. Although not considered absolutely essential, it is good policy to bond the drive shaft housing approximately every 18". When in place and secured, the shaft should be tested for free operation before connecting to the instrument or the engine and again after being attached to the tachometer. Any binding must be eliminated. The overall length of the shaft should be limited to twenty feet.

If two-way or 90° adapters are being used, check them carefully, as they seldom prove satisfactory.

If possible, the drive-shaft take-off at the rear of the case should be installed at the bottom but in some P.T. installations it is necessary that this point be rotated to the right or left, in which instance the dial and pointer must be reset.

If, after checking with the above notations, your trouble persists, its cause probably lies within the instrument itself and I refer you to Army Technical Order 05-5, concerning the specific type of mechanical tachometer.

Q. "C. K." (Mississippi) asks, "Are service activities authorized to break the stamped seal of an instrument?"

A. Never.

Q. Is there any general way of ascertaining which checks are to be made on the daily and which are to be accomplished on the preflight inspections?

A. Normally, all indications consistent with engine speeds and requirements and inspections for excessive pointer oscillation are accomplished on the preflight, while those which do not require that the engine be running are made on the daily inspection. The purpose of the preflight is to determine that instruments are functioning properly.

automatic ruling of graduations on linear scales with the

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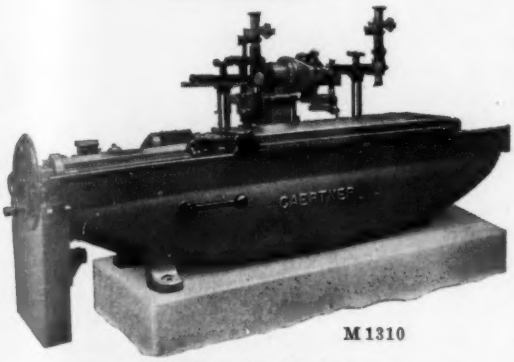

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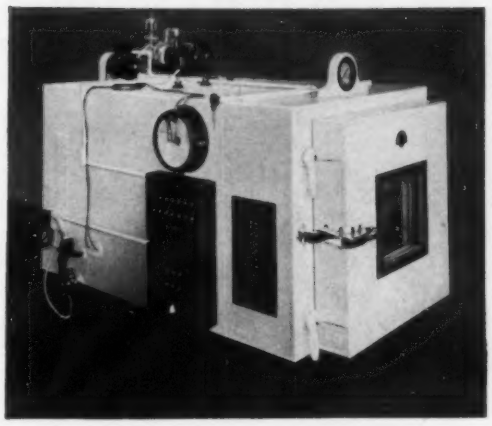

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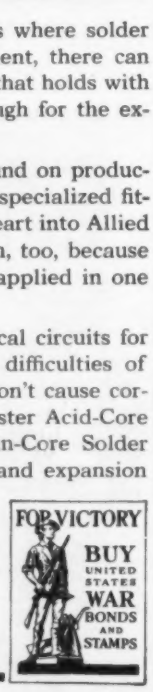

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KESTER
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STANDARD FOR INDUSTRY

Continued from page 187

the devices using them might be called ionic devices, or perhaps still better *electro-ionic*, indicating that they use both free electrons and ions.

The ions in an ionic or electro-ionic device are generally produced by the free electrons themselves. If the circumstances are such that free electrons acquire ten to twenty volts of kinetic energy and then strike neutral molecules, the neutral molecules are broken up into positively charged ions, and other free electrons. Conversely, as we shall point out presently, the ions may produce free electrons, so that a new possibility arises, namely, the self-maintaining gas discharge, as in the glow in the neon sign, the quick-acting spark in the lightning arrester, the energetic arc in the electric circuit breaker and the silent cleansing discharge in the precipitron.

The ions in an electro-ionic device generally exercise a useful function in neutralizing the space charge of the free electrons. When large numbers of free electrons are introduced into a space, the electrical effects of their charges are additive, and large electrical fields are produced. These fields react on the motion of the electrons and the net effect is that only by using excessively large impressed voltages can large currents be carried by free electrons alone. If, however, a corresponding number of postive ions are interspersed among the electrons, the additive effect of the charge on the electrons is neutralized, and large currents may be carried by quite low impressed voltages. For example, in the ignitron tubes supplying the direct current for making aluminum and magnesium, thousands of amperes are carried with a voltage of less than twenty volts. Without the space charge neutralizing effect of the positive ions, the use of free electrons for rectifying large alternating currents would be impracticable.

Another useful function of ions in electro-ionic devices is their action in setting free electrons at the cathode, so that a hot filament is not a necessary element in an electro-ionic tube. The cathode-ray tubes which J. J. Thomson used in discovering the electron, and the tube which blackened Roentgen's photographic plate, had in them no thermionic filament. But ions in the gas striking the cathode set free the electrons which started the electronic age.

When the current density at the cathode is sufficiently large, a new phenomenon appears, the so-called cathode spot, which sets free enormous numbers of electrons from the otherwise unheated cathode. Thousands of amperes of free electrons per square inch emerge from the cathode spot with a voltage drop of less than twenty volts. The detailed mechanism of the cathode spot is still not known, but there is little doubt that the positive ions are an absolutely necessary part of this mechanism.

It is extremely easy to produce such a cathode spot. Davy in 1808 separated a pair of carbons in a circuit carrying a few amperes, and produced the dazzling electric arc, with its free electrons, ions, and cathode spot. Thus an electro-ionic device appeared for scientific experiment nearly a century before the discovery of the electron. Also anteceding the electron discovery, the electrical in-

dustry started street lighting with electric arcs and, before the knowledge of the free electron was widespread, was using mercury arcs in glass tubes for supplying the direct current for the series arc street-lighting systems. Thus the electrical engineers of that time were practicing "electronic engineering" without knowing it, like the famous character in Molière's play who was surprised to find that he had been speaking prose all his life without knowing it.

But while these electro-ionic devices are simple in their physical structure, enough has been said to indicate that their theory is complex and that they present problems upon which "electronic science" has shed light, but still has not solved. We may confidently expect, however, that these problems will be more and more resolved by the electronic scientists and engineers of the future. And with the resolution of these problems, far-reaching improvements of the older electro-ionic devices will result, as well as the invention and development of entirely new devices.

To consider a few specific instances, let us regard first the homely electric switch. In the mid 1920's the expansion of the electrical power systems was threatened with an impasse because the limit in interrupting capacities of the circuit breakers then available had been reached. The arcs formed between the separating contacts in switches in these large current high voltage systems could not be extinguished by the available means. Then in 1928 one of the first of a series of revolutionary developments was announced by an electrical equipment manufacturer under the name De-ion, thus bringing out into the open that the switch was now an electro-ionic device, and that its future progress depended on the contributions which would be made to it by electronic science. The conductivity of the electric arc was recognized as due to presence in the gas space of free electrons and ions, and the problem of the proper extinction of the arc at the proper moment, was the problem of de-ionizing, or making disappear at the proper moment, and sufficiently rapidly the free electrons and ions which the arc itself engendered. The development of de-ionizing means, while guided by electronic theory, is still largely empirical. In the future, much of this empiricism may be removed by electronic science, and new electro-ionic switches of extraordinary capacity may be expected.

The ignitron is another example of how modern electronic science revolutionized an older electro-ionic device. The mercury arc rectifier was invented by Peter Cooper-Hewitt in 1903, shortly after the discovery of the electron. Cooper-Hewitt did not talk of free electrons, and their emission from the cathode, but spoke of a vague "cathode reluctance" to explain the rectifying effect he had found. This was his way for describing the fact that emission of free electrons from the cathode is a necessary part of conducting current through mercury vapor, and that by providing one electrode from which electrons are freely emitted, and another from which such emission is lacking, a rectifier of alternating current is obtained. A cathode-spot, initiated by breaking contact between the mercury pool cathode and an auxiliary electrode, was Cooper-Hewitt's method of producing electron emission from the cathode.

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Under the guidance of electronic science, the mercury arc rectifier in the 1920's was developed up to large sizes, and particularly in Europe displaced dynamo-electric converters for railway electrification and in the electro-chemical industry.

About 1930, the use of stainless steel and light metals was rapidly expanding, particularly in transportation equipment, and methods for rapid electrical welding were devised. For welding of such metals it is necessary to use a rapid sequence of accurately measured pulses of electric current, accurately timed. Mechanical switches, because of their inertia, were not practical for controlling these current pulses. It was very natural by this time to turn to electronic science for the answer, and because of the large currents involved, an electro-ionic type of tube was indicated and particularly the mercury arc tube, with its indestructible mercury pool cathode made electron emissive by means of a cathode spot.

However, the only reliable means for starting a cathode spot known at that time was that of mechanically breaking a circuit comprising the mercury pool and an auxiliary electrode, and again mechanical inertia introduced insuperable difficulties. What was wanted was a purely static means for initiating the cathode spot at great frequency and under perfect control.

Electronic science gave a beautiful solution to this problem. A rod of high-resistance material was stuck down into the mercury, and current passed down through the rod into the mercury. Analysis of electrical conditions at the junction of the rod with the mercury indicated that there would be there a large concentration of current, and an intense field, just the conditions for starting a cathode spot. Experiment bore out this expectation. Sure enough, when a few amperes passed down the resistance rod, a cathode spot appeared on the adjacent mercury. This could be done as quickly and repeatedly as desired. The small current for thus initiating the cathode spot could be readily handled by a more usual thermionic grid-controlled electro-ionic tube. After the cathode spot was formed, thousands of amperes needed by the weld would pass through the mercury arc tube. Thus the ignitron was born. It immediately found wide application in thus electronically controlling the welding of these new materials.

It was then found that the use of this gift of electronic science, the mercury-arc ignitor, permitted a radically new design of the high-power mercury-arc rectifier with a better efficiency and greater reliability than had been attained before. Hence we find that in the great expansion of production of aluminum and magnesium occasioned by the war, the tremendous direct currents needed for electrolysis are being supplied by the new ignitron mercury arc rectifiers.

These examples are only a few of the instances where electronic science is modifying and improving the apparatus of the electric-power industry. We may be quite sure that the next steps in electrical engineering will include further improvements in electro-ionic apparatus—and wider applications.

Substance of address before the Science Talent Institute attended by the forty winners of the Second Annual Science Talent Search (competition for the Westinghouse Science Scholarships), March 1, 1943, Hotel Statler, Washington, D. C.

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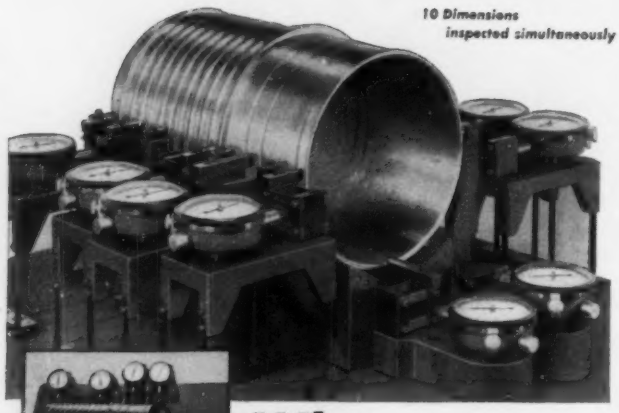

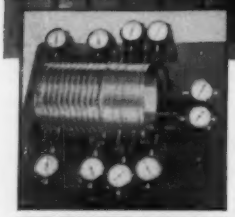

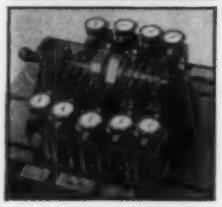

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Ordnance Production Gaging

Continued from page 195

however, wrung to a master flat or to another more sturdy gage block (a block over 0.200") will show excellent flatness.

When scratches occur, these may be removed from gage blocks with a very fine stone of the Arkansas oilstone type or finer. If the burrs are removed carefully, no particular difficulty will be apparent in wringing and the block will not scratch other blocks. *Caution: Burrs or scratches should never be removed by personnel who have not had long experience with gage blocks.*

GROUP II

Master Cylindrical Square

The master cylindrical square, Fig. 8, is in the same class as gage blocks in that there is no substitute. The measurements which may be made in a gage laboratory are confined (hardness excluded) to either angular or length measurements. As the gage block is the standard for length measurement, so the master cylindrical square is the angular standard. In material, workmanship and accuracy, it corresponds to the gage block. Its surface finish resembles that of the gage block in appearance and quality; and the square should be handled with the same respect as are gage blocks. It is not used in every set-up as is the gage block. In fact, the frequency of its use is likely to be rather limited—say once a week in a "busy" laboratory. Therefore, extreme care should be used in its storage. After use, it should be cleaned with acetone or carbon tetrachloride to remove all possibility of stain or corrosion on the surface due to deposits of body acid by the hand, and it should then be coated with a rust-resisting rust-inhibited oil or grease.

(To be continued)

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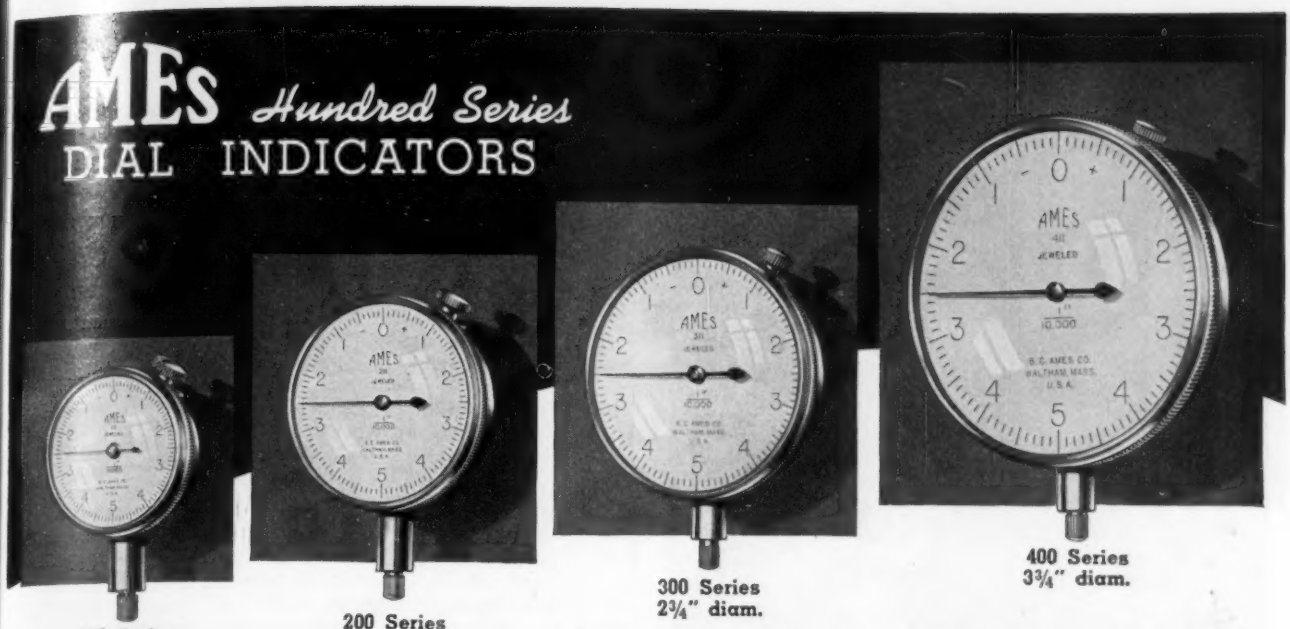

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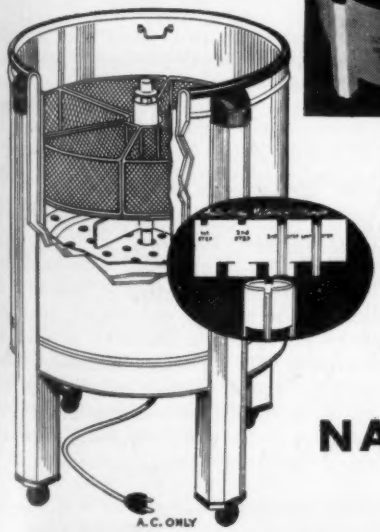

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3. Keeps disassembled parts together; no mixed or missing parts.

4. Work comes out like new.

5. Compartments can be lifted out. Larger parts can be just as thoroughly cleaned.

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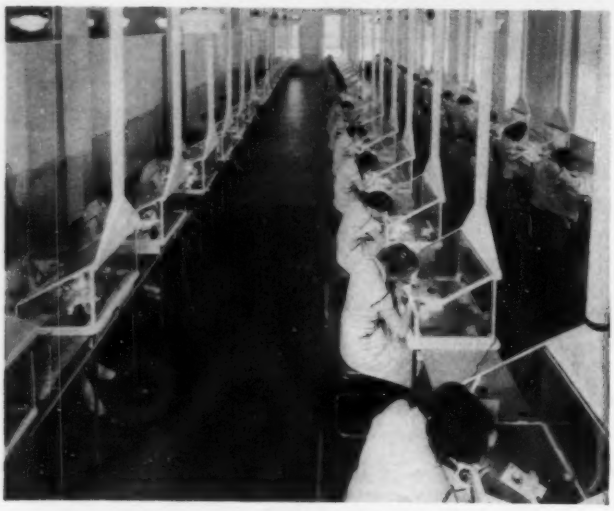

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56 SUMMER ST. BOSTON, MASS.

Electrical Instruments Standardized

Continued from page 190

The arrangement of the remainder of this article resembles the arrangement of portions of C39.2 (and some of the headings are copied from the headings of important sections or paragraphs of C39.2) but the reason is the writer's intention to convey to the reader an undistorted (but not detailed) picture—to create a desire on the part of the reader for the complete 48-page original.

CLASSIFICATION

This war standard covers the basic requirements applicable to 2½" and 3½" round, flush-mounting, panel-type electrical indicating instruments, classified as follows:

Direct current.	Millivoltmeters
Alternating current, power frequencies.	Voltmeters
Alternating current, radio frequency.	Kilovoltmeters
Alternating current, rectifier type.	Microammeters
	Milliammeters
	Ammeters
	Kiloammeters
	Special instruments as listed

Nomenclature Limitation.—

Millivoltmeter: 0-999 millivolts, inclusive.
Voltmeter: 1-999 volts, inclusive.
Kilovoltmeter: above 999 volts.
Microammeter: 0-999 microamperes, inclusive.
Milliammeter: 1-999 milliamperes, inclusive.
Ammeter: 1-999 amperes, inclusive.
Kiloammeter: above 999 amperes.

Frequency (Alternating-current Instruments).—

60 cycles (operating range 25 to 125 cycles per second)
400 cycles (operating range 360 to 440 cycles per second)
800 cycles (operating range 720 to 880 cycles per second)
Audiofrequency
Radiofrequency

APPLICABLE SPECIFICATIONS

The specifications listed below form a part of C39.2 but are not furnished with it:

American Standards:

B1.1-1935 Screw Threads for Bolts, Nuts, Machine Screws and Threaded Parts
C39.1-1938 Electrical Indicating Instruments

American Recommended Practices:

C16.5-1942 Volume Measurements of Speech and Program Waves

Army-Navy Aeronautical Specifications:

AN-L-1 Luminescent Material; Fluorescent

Federal Specifications:

TT-R-58 Radioactive-Luminous-Compounded and Adhesives, *dated April 9, 1941*, with Amendment 1, *dated Sept. 19, 1941*

U. S. Navy Department, Bureau of Ships:

17-I-20 Instruments, electrical measuring; resistors, shunts and transformers for, *dated Oct. 1, 1942*
17-P-4 (INT) Phenolic-material, molded, *dated June 1, 1941*
17-P-5 (INT) Phenolic-material, laminated, *dated May 1, 1940*
RE 13A 590A Resistors, multiplier, fixed, precision, wirewound, *dated Dec. 1, 1939*

U. S. Army:

100-2D Standard Specification for Marking Shipments, *dated Feb. 4, 1933*, with Amendment No. 1, *dated July 6, 1936*

MATERIAL AND WORKMANSHIP

The material for each part is specified. . . . "best design and practice for tropical and cold climates . . . "

Substitution of Material.—" . . . evidence to substantiate claims that such substitute is equal to that originally specified. At the discretion of the agency concerned, test samples may be required to prove the suitability of the proposed substitute." [We quote this verbatim because it shows recognition of the dawning age of *better* substitutes, most of them made possible by modern instrumentation.]

Soldering, Standard Screw Threads, Locking of Screw-Thread Assemblies, and Molding are all covered in the standard.

DETAIL REQUIREMENTS

Design and Construction.— . . . close-fitting joints . . . limit the entrance of dust and moisture. . . . Under the

humidity cycling test, instrument shall continue to function satisfactorily and retain its accuracy within the limits prescribed. Instrument case need not be water-tight.

The instrument dial shall be made of stiff material . . . freedom from warping or deterioration under the extreme conditions of temperature and humidity encountered in use by the agency concerned.

Paper dials will be satisfactory only when adequately bonded to and backed by a metal support and when they meet all the specified tests without fading, discoloring, warping or other deterioration.

The minimum scale lengths shall be 1.5″ for 2½″ instruments, and 2″ for 3½″ instruments.

Except where otherwise approved, the angle subtended by a scale division shall be not less than 1 degree.

Wherever practicable, the numbers marked on the scale, except in lower part of non-uniform scales, shall be by steps of 1, 2, 3, or 5, or a decimal multiple or submultiple of any of these numbers. Figures as large and as legible as practicable; form in accordance with drawing C39.2-3; so spaced as to render individual numbers clearly distinguishable.

Pointer suitably formed to permit accurate readings at the usual distance from which viewed, and to permit approximate scale readings up to the distance of legibility of the scale markings. Sufficiently rugged for its intended purpose.

To avoid parallax, clearance between pointer index and graduated scale shall not exceed 0.1″.

Where self-luminous pointers are called for, the self-luminous material shall be applied over the pointer for at least ¼″ from the tip.

If a laminated permanent magnet is used, the laminations shall be securely clamped together.

Moving systems of instruments of the same manufacturer's type or model number shall be positively interchangeable, so that each part will fit any instrument of same manufacturer's type or model number without necessity for any mechanical alteration. Ease of replacement and interchangeability of complete moving elements shall be actually demonstrated on each type of instrument.

Moving elements shall turn on hardened accurately-ground and highly-polished steel pivots bearing on highly-polished, first quality sapphire or diamond bearings or other materials that have been approved as an alternate to precious gems. [As many *Instruments* readers know from statements passed by censors, millions of rustless precious-metal alloy pivots and millions of glass bearings are in effect "Standard" for many types of Army and Navy instruments that stand up under extreme climates.]

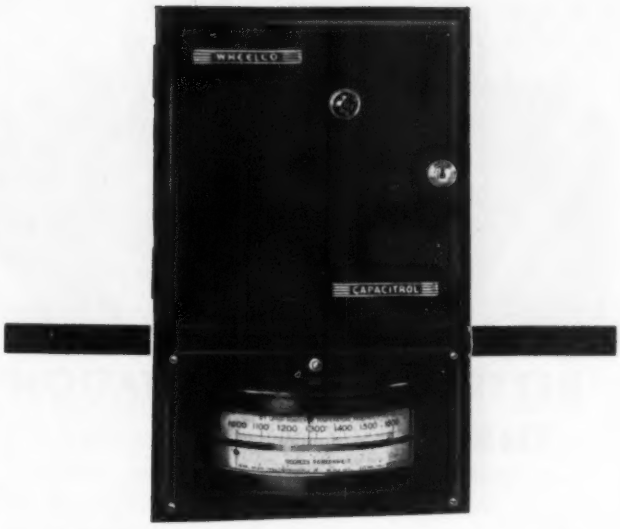
Moving element shall be balanced by approved means (such as threaded lock or split nuts, or a wire helix moving along a cross arm and counterweight arm) with easily accessible provision for rebalancing. Use of solder, shellac, or similar means for holding threaded balance nuts not approved as it prevents ready rebalancing.

In general, instruments shall have some practicable shop means of adjustment to accuracy. Charging of the magnet, and magnetically treating to accuracy, shall be considered as meeting this requirement. [This bears out war correspondents' stories of well-equipped American repair shops all over the globe.] Internal resistances shall be easily accessible.

All instruments having spring control shall have a zero adjuster, accessible from front of case unless otherwise specified. Zero adjuster shall be suitably insulated, shall have sufficient friction to prevent shaking loose under vibration tests specified.

Terminal studs firmly anchored to the base of the instruments in such manner as to prevent turning; threaded full length. Each terminal stud furnished with two loose nuts and two loose washers.

On all d-c. instruments, the left-hand terminal (looking at the rear of the instrument in the position as normally mounted) shall be the positive terminal and marked + on or near the terminal. On all r-f. instruments the left-hand terminal (looking at the rear of the instrument in the



Wheelco is still FIRST

. . . in pioneering new applications for engineered electronics in temperature control.

The famous Wheelco "Electronic Principle" Control System provides faster, more accurate control than any other type of control and is constantly being applied to more control problems.

In 1941, Wheelco incorporated the instantaneous control action of the "Electronic Principle" and extreme accuracy of temperature measurement into the UNIVERSAL Temperature Controllers, which are the first to provide such plus values as interchangeability of all component parts, interchangeability of scale ranges, ready accessibility of all parts for individual checking and many other features. UNIVERSAL Controllers include Capacitrols, Potentio-trols, Limitrols and Resistance Therm-otrols.

In 1943 Wheelco continues to pioneer new control applications for the "Electronic Principle." *Write for FREE Bulletin No. Z6000.*

1935

"Electronic Principle" Temperature Control (D2)*.
Limitrols (D202)*.
Indicating Pyrometers (D302)*.
"ELECTRONIC PRINCIPLE" TEMPERATURE CONTROL — since proved superior to other types of controllers.

1936

Flame-otrol (L2)*.
Portable Indicating Pyrometers (D602)*.
FLAME-OTROL — only combustion safeguard for all fuels approved by both Underwriters' Laboratories and Factory Mutual Laboratories.

1937

Proportioning Control (D2)*.
Portable Potentiometers (A502)*.
Heat-eyes (S2)*.
Time Delay Relays (S302)*.
PROPORTIONING CONTROL for continuously varying fuel input to maintain constant temperature—applied to "Electronic Principle" Controllers.

1938

Potentio-trols (A2)*.
Program Control (D2)*.
Rheotrols (J302)*.
Flame-eyes (L302)*.
Automatic Ignition Flame-otrols (L2)*.
POTENTIO-TROLS — Potentiometric method of temperature measurement combined with "Electronic Principle" Control.

1939

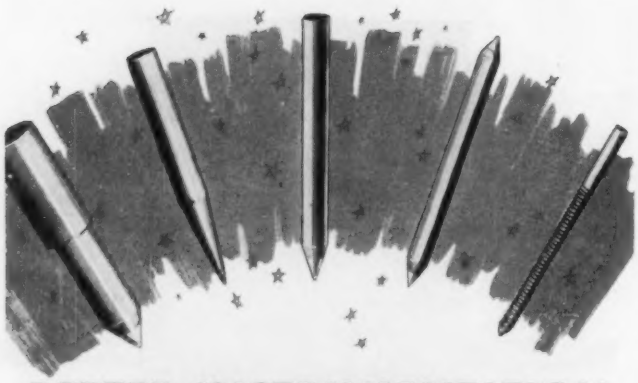
Indicating Therm-otrol (G502)*.
Indicating Thermometers (G303)*.
Recording Thermometers (G403)*
"ELECTRONIC PRINCIPLE" INDICATING THERMOMETER CONTROLLERS — for low temperature applications.

1940

Recording Therm-otrol (G502)*.
The THERM-OTROL, Recording Control Thermometer. Available in any type of measuring and control system for ranges from —50 to + 1000°F.

*(No.) indicates Bulletins describing instrument. Write for them!

Wheelco Instruments Co.
833 W. Harrison Street Chicago, Illinois
Wheelco—Originator of "Electronic Principle" Temperature Controls.



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TRADE MARK

"The Invisible Guardian" of dependable, precise instrumentation. Aeropoint Pivots will remain more accurate longer because they are not affected by vibration, heat, cold, moisture, magnetism, corrosion. Welded tips often simplify designs and assembly.

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MANUFACTURING ENGINEERS

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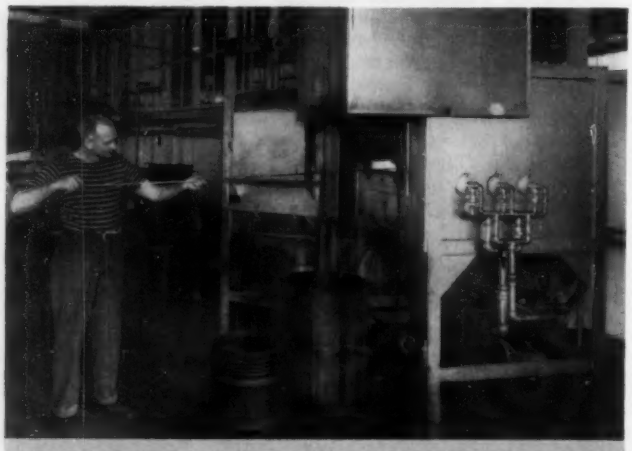
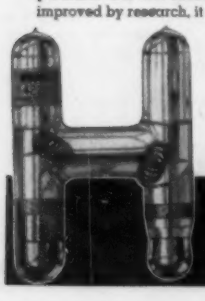


UNIFORM MASS PRODUCTION
Because of ACCURATE Temperature Control

IN many industries involving high temperature or pH control, mass production is no obstacle to UNIFORMITY. Potentiometers, providing AUTOMATIC control within close limits, have made this possible.

For 26 years "the heart" of most potentiometers has been the Eplab Standard Cell. It is a "yardstick" for translation of voltage to temperature. The first American commercial cell of its type, constantly improved by research, it is as "standard as sterling".



Get ACCURATE temperature or pH control with potentiometers and make sure the standard cells are EPLAB.

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SCIENTIFIC INSTRUMENTS
NEWPORT, RHODE ISLAND, U. S. A.

EPLAB STANDARD CELLS
For Potentiometric Instruments
AS STANDARD AS STERLING

position as normally mounted) shall be the low-potential terminal and marked G. All markings legible and permanent.

R-f. instruments and d-c. kilovoltmeters shall have the magnetic system, dial, and metallic bezel ring (if used) connected to one terminal. This shall be the terminal marked G in r-f. instruments. Bezel ring connected by means of a reliable brush contact or other approved means so that mechanism may be readily withdrawn.

Resistance to Corrosion.—

All metal parts shall be of corrosion-resisting material or of a material treated in an approved manner to render it adequately resistant to corrosion. Suitability of corrosion-resistant metals or treatments shall be demonstrated by qualification tests specified.

A high degree of polish on hardened steel pivots will be considered as satisfactory protection of these parts.

"No material which may give off deleterious fumes when heated shall be used in instruments." [Exact wording. Could be improved. "May" seems too strict. "Heated" is not quantitative. Many excellent organic insulating materials give off injurious fumes when "heated."]

Protective coatings and finishes which will melt, crack, chip, or scale during normal service life or due to extremes of atmospheric conditions shall not be used.

Interiors of instruments free from metal filings, dust, or other loose particles which might tend to lodge in the air gap.

Instruments shall be self-contained unless otherwise specified on applicable drawing.

For instruments not self-contained there shall be furnished, unless otherwise specified, the necessary shunts, external thermocouples, or multipliers, as applicable.

Instruments having separate devices upon which the scale marking is dependent (shunts, resistors, reactors, thermocouples, etc.) shall be suitably marked to indicate same. If instrument rating differs from full-scale marking, rating so marked on dial, *e.g.* "Use with external resistor, FS = 1 ma"; "Use with external shunt, FS = 50 mv," etc.

In the case of a-c. instruments used with current and potential transformers, additional instrument markings are specified.

PERFORMANCE

Reference Temperature shall be 25°C. (77°F.) unless otherwise specified.

Instrument Calibration.—With scale in vertical position in which normally mounted or used, and shall meet the specified accuracy requirements in such position and at 25°C. R-f. instruments shall be calibrated on 60-cycle a.c.

Balance.—When spring-controlled instruments are tilted 60° from vertical, in any direction, pointer tip shall remain within 2% of total scale length of the zero point. Elements free to swing shall show a good mechanical balance.

Initial Accuracy at the reference temperature shall be ± 2% of full-scale value. Rectifier-type instruments shall have initial accuracy as approved.

Damping Factor not less than the following:

D-c. 2½" and 3½" ammeters and milliammeters	2.5
D-c. 2½" and 3½" voltmeters and kilovoltmeters	2.0
A-c. 2½" and 3½" voltmeters	1.7
R-f. 2½" and 3½" ammeters and milliammeters, conventional scale	20.0
R-f. 2½" and 3½" ammeters and milliammeters, linear expanded scale	2.5

Response Time when voltage or current corresponding to ⅔ linear scale length is suddenly applied shall not exceed the following for the various types:

D-c. microammeters	3 seconds
D-c. voltmeters, ammeters, and milliammeters	2 seconds
A-c. and R-f. ammeters and milliammeters and A-c. voltmeters	2.5 seconds

Power Consumption. — Unless otherwise specified, d-c. voltmeters shall have a sensitivity of 1000 ohms per volt (1 ma. full-scale deflection) and d-c. microammeters and milliammeters a maximum terminal drop of 150 millivolts. Self-contained d-c. ammeters, full-scale terminal drop of 50 millivolts ± 10%; d-c ammeters using external shunts,

EVERY DAY we are shipping these precision pressure gauges to be used in place of dead weight testers. They are accurate, dependable and easy to read. Delivery—2 to 6 weeks.

RANGE FROM 0-60 lbs. to 0-10,000 lbs

12" Dial..... 144.00

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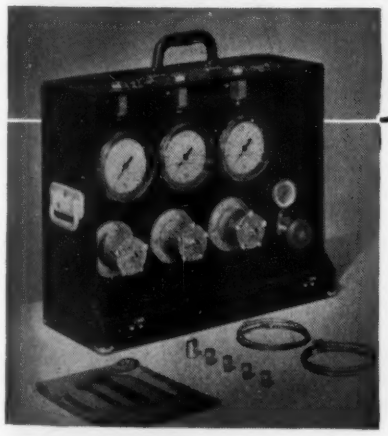
The GROVE *Pneumatic Gauge* COMPARATOR



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- Compact, portable and fully self-contained.
- Built-in high capacity rechargeable air cylinders.
- Precision laboratory test gauges accurate to within ¼ of 1% full scale.
- Completely equipped with tubing, connections and accessories.

Figure the amount of time, trouble and money you save when you check your pressure gauges "in-place" without removing them from their panels or mountings; without disturbing existing line connections. The portable Grove Pneumatic Gauge Comparator gives you this fast accurate means of accurately checking any service gauge in service. Write today for Bulletin 300.

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THE *Telechron* MOTOR

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IN WAR INDUSTRY

• Self-starting, synchronous Telechron timing motors are used by most American instrument makers and are serving virtually every war industry today.

• There are good reasons why. The motors are small, strong, accurate. They're available from 12 to 250 volts, and from 1 to 1800 R.P.M. They are easily adapted to almost any controlled frequency circuit and any industrial application, including:

TIMING	SIGNALING
CONTROLLING	FIXED PROCESS CONTROLLING
METERING	
RECORDING	MEASURING
SWITCHING	GAGING
CYCLING OPERATIONS	REGULATION
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• Telechron motors operate indispensable instruments of many kinds for the Army, Navy and Maritime Commission—for the Rubber, Chemical, Metal, Aviation, Petroleum, Power, Textile, Telephone and other industries.

• Naturally, we've learned a lot in the process of working out all these varied applications. Our experience and our information are at your service if we can help you in any way to speed up or improve your production for Victory.

WARREN TELECHRON CO.

Ashland, Mass.

★ ★

A Better Pivot for Precision Instruments!

PERMOPIVOTS*

TIPPED WITH PERMOMETAL* ALLOY

PERMOPIVOTS are tipped with a special alloy which has the following exceptional qualities:

☑ **WEAR RESISTANT** . . . The Permometal tip gives precision instruments longer life and greater accuracy under actual operating conditions.

☑ **NON-CORROSIVE** . . . Permopivots cannot rust or corrode.

☑ **NON-ABRASIVE** . . . The satin-smooth tip eliminates abrading particles of wear.

☑ **ELIMINATES OIL** . . . It is often possible to eliminate oil because of the extremely low coefficient of friction with Permopivots.

* T. M. REG. U. S. PAT. OFF.

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full-scale terminal drop of 50 millivolts ± 2%. Self-contained power frequency a-c. instruments, power consumption of not more than 4 watts at full-scale deflection.

Effective Resistance of Rectifier-type Power and Volume Level Indicators.—As specified for the particular instrument when measured by the voltage-doubling method and shall not change more than 10% within 3 db of the reference deflection mark.

Voltage Drop.—For r-f. instruments, resistance drop across heating element at full-scale deflection shall not exceed the following unless specifically approved:

0.25 volt for ranges of 10 amperes and over.
0.3 volt for ranges of 6 to 9 amperes.
0.4 volt for ranges of 3 to 5.9 amperes.
0.5 volt for ranges of 1 to 2.9 amperes.
0.65 volt for ranges of less than 1 ampere.

Frequency Range.—A-c. instruments for 60-cycle normal frequency shall operate satisfactorily over range of 25 to 125 cycles. For 400-cycle service, 360 to 440 cycles; for 800-cycle service, 720 to 880. For r-f. instruments, working range in frequency taken as 25 cycles to 30 megacycles unless otherwise specified. R-f. instruments shall be calibrated on 60-cycle a.c. unless calibration for a particular frequency or frequency range is specified for special applications.

Power Frequency Influence for a-c. instruments intended for 60-cycle circuits, not greater than 0.5%; for instruments intended for use on 400- and 800-cycle circuits, not greater than 2%.

Limiting Temperature Rises of Instrument Windings are given in a table:

Method of temperature determination	*Limiting observable temperature rise*	
	Class A insulation	*Class B insulation*
Thermometer	50°C.	70°C.
Resistance	55	75

Temperature Influence at the reference temperature shall not exceed the following:

A-c. current circuits—0.25%.
D-c. current circuits—1.0 %.
D-c. voltage circuit—0.33%.
A-c. voltage circuit—0.75%.

Heat Effect at 65°C.—Instruments shall indicate freely after having been maintained at this temperature in heated air for 24 hours. Error shall not exceed proportionate error allowed in the preceding paragraph for instruments having a linear temperature coefficient. Error for r-f. instruments shall not exceed 8%; error for rectifier-type instruments shall be as approved. After instruments have been restored to reference temperature, *permanent error* due to heat tests shall not exceed 0.5%. There shall be no increase in the above errors when instruments are subjected to further heat cycles.

Low Temperature Exposure.—Instruments shall operate satisfactorily during and subsequent to exposure to a temperature of —55°C. Permanent error after exposure shall not exceed 1%. [Cold chamber test procedure is specified.]

Ruggedness and Overload Capacity.—

General.—Instrument mechanism sufficiently strong and rigid to enable instrument to withstand, without appreciable damage, ordinary transportation, handling, and installation.

Momentary Overload, Current Circuits.—Mechanism of a-c. and d-c. instruments having current circuits sufficiently rugged to withstand, without mechanical or thermal injury, a series of momentary overloads [as detailed in a later paragraph]. This requirement not applicable to r-f. instruments.

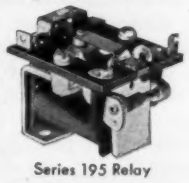
Sustained Overload, Current and Voltage Circuits.—Withstand an overload corresponding to 120% rated capacity for 6 hours without damage or a change in indications at any part of the scale of more than ⅛ of 1% except for rectifier-type power and volume level indicators which shall withstand a load corresponding to five times the 0 level deflection. When load is withdrawn, pointer shall not show a temporary zero shift greater than 1% nor a permanent zero shift greater than 0.5% of scale length. Temporary

RELAYS BY GUARDIAN MEET ALL CONTROL NEEDS . . .

★ Whether the principle is electronic or magnetic . . . whether the job requires a tiny A.C. relay or a heavy-duty D.C. solenoid . . . whether time delay or instantaneous action . . . there is usually a "Relay by Guardian" to meet the "specs" on most applications . . . from animated electric signs to electric chokes for the Army's amphibious tractors.

A *Midget* Relay . . . for tight places . . .

The tiny series 195 relay shown at the right weighs less than an ounce, but it's a cocky and energetic little bantam . . . full of life and fight . . . in a small way, of course—but plenty sufficient for its job in aircraft, radio and other applications where small size and lightweight are at a premium. Write for Bulletin 195.

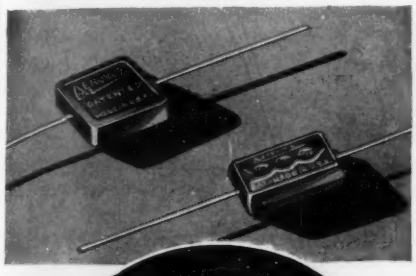


Series 195 Relay

GUARDIAN ELECTRIC

1630 WEST WALNUT STREET CHICAGO, ILLINOIS

A COMPLETE LINE OF RELAYS SERVING AMERICAN WAR INDUSTRY



MICAS made to tolerances of 1%

- Silvered micas molded in red low-loss bakelite.
- Average temperature coefficient +.003% per deg. C. Practically no capacity drift with time.
- Q as high as 3000 to 5000 in higher capacities. Tolerances to 1%. .000001 to .0025 mfd. 1000 v. .0003, .004, .005 mfd. 600 v.

● For critical applications requiring precise low-capacity values, Aerovox recommends its silvered micas, molded in bakelite. Available today on high priorities only. Used in the finest quality assemblies.

● Write for data. Submit that capacitance problem.

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Standard Electric PRECISION TIMERS *for* MEASURING AND INDICATING ELAPSED TIME INTERVALS

Important Features

- ELECTRO-MAGNETIC CLUTCH
- CONTROLS MAY BE CUSTOM BUILT TO SUIT SPECIAL REQUIREMENTS
- INSTANTANEOUS RESET TO ZERO
- SYNCHRONOUS MOTOR POWERED
- INTEGRATES CONSECUTIVE TIME INTERVALS
- BAKELITE CASED OR PANEL MOUNTED

Regularly made in the following models:

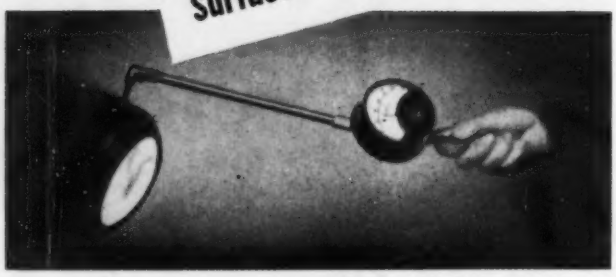
S-100	reads in 1/5	seconds to total of 6000 seconds
S-60	reads in 1/5	seconds to total of one hour
S-10	reads in 1/10	seconds to total of 1000 seconds
S-1	reads in 1/100	seconds to total of 60 seconds
MSTE	reads in 1/1000	seconds to total of 6 seconds
SM-60	reads in 1/100	minutes to total of one hour
S-6	reads in 1/1000	minutes to total of 10 minutes

THE STANDARD ELECTRIC TIME COMPANY

75 Logan St., Springfield, Mass. Branch Offices in Principal Cities

"STANDARD MAKES EVERY SPLIT-SECOND COUNT"

Alnor
IMPROVED PYROCON
for quick accurate surface temperatures



● The *Alnor* Pyrocon is a convenient all-purpose surface temperature pyrometer ideally suited to a great variety of industrial plant needs.

Accurate temperature readings are obtained in a few seconds of plastic materials, liquids, oils, and similar materials, and flat or curved, stationary or moving surfaces.

The rugged, shock-resisting movement is used with any one of eleven types of thermo-couples, interchangeable without adjustment or re-calibration. Choice of rigid or flexible arms, or both, instantly interchangeable. Built in several standard ranges, 0-300 deg. F. to 0-1200 deg. F. Write for Bulletin 3511 giving complete description.

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We Don't Grope Blindly When Measuring Valuable Stored Liquids... We Check With
LIQUIDOMETER *Tank Gauges*
"THEY'RE ALWAYS DEPENDABLE"

Now, more than ever, industrialists realize the importance of having accurate measurements of their stored liquids available at all times. LIQUIDOMETER Tank Gauges insure true, convenient, hazard-free, 100% automatic readings. No pumps, valves, or auxiliary units required to read them. Models are available so that readings can be taken remotely from or directly at the tank. Remote reading types utilize balanced hydraulic transmission system which completely compensates for temperature variations on communicating tubing. Accuracy unaffected by specific gravity of tank liquid.

Approved for gauging hazardous liquids by Underwriters' Laboratories and similar groups.

Models available to automatically control pumps, motors, signals or other devices for maintaining minimum or maximum liquid levels.

Write for complete details

THE LIQUIDOMETER CORP.
36-27 SKILLMAN AVE. LONG ISLAND CITY, N. Y.

zero shift is measured immediately after load is withdrawn; permanent zero shift 24 hours later.

Short-time Overload for R-f. Instruments. — Withstand 150% full-scale current for two minutes without damage to any part or more than ⅓ of 1% change in indications at any part of scale. Accuracy shall be determined 20 minutes after the overload test.

Heat and Humidity Effect at 82°C., 95% Relative Humidity.—Instruments shall operate satisfactorily during and subsequent to exposure to this atmosphere in accordance with a specified test procedure. Permanent error after exposure shall not exceed 1%.

Humidity Resistance.—Instruments shall operate satisfactorily following exposure to specified humidity test.

Effect of Vibration.—Permanent errors in the indication, due to vibration as specified, shall not exceed 1% of full-scale deflection. No screws, bearings, pivots, or other parts shall become loosened or damaged.

Effect of Shock.—Permanent errors in the indication, due to shock as specified, shall not exceed 1% of full-scale deflection. No screws, bearings, pivots, or other parts shall become loosened or unduly damaged.

Dielectric Strength.—Instruments shall successfully withstand the application of specified a-c. potentials.

METHODS OF INSPECTION AND TESTS

This section occupies six pages. Any attempt to boil down its contents would result in a distorted picture. For example the list of the instruments which are to be submitted by the manufacturer as samples for *qualification tests* is in the form of a table which occupies more than half a page. Ten sample instruments of each required type are required to be submitted. These sample instruments are subjected to the following tests (as applicable) in the listed order:

Visual Inspection	Frequency Influence
Balance	Temperature Rise
Zero Adjustment	Temperature Influence
Sticking below Zero	Heat Effect at 65 Degrees Centigrade
Initial Accuracy	Low Temperature Exposure
Damping Factor	Ruggedness and Overload Capacity
Response Time	Dielectric Strength
Power Consumption	Insulation Resistance
Voltage Drop	
Frequency Range	

The sample instruments are then divided into four equal groups and subjected to the following tests in the listed order:

Group 1	*Group 3*
Heat and Humidity Effect at 82°C., 95% Relative Humidity	Effect of Vibration
Visual Inspection	Visual Inspection
	Interchangeability
Group 2	*Group 4*
Humidity Tests	Effect of Shock
Visual Inspection	Visual Inspection

Then come the *production-sampling tests.* The standard prescribes the method of selection and the test routine for the selected samples: they are subjected to the following tests in the listed order:

Visual Inspection	Response Time
Balance	Ruggedness and Overload Capacity
Zero Adjustment	Dielectric Strength
Sticking below Zero	Insulation Resistance
Initial Accuracy	Visual Inspection
Damping Factor	

Finally, in the routine for *production tests,* every instrument on order is subjected to the following tests in the order listed below:

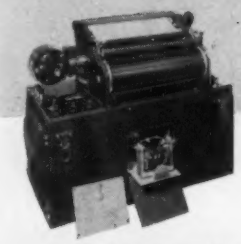
Visual Inspection	Initial Accuracy
Balance	Visual Inspection
Sticking below Zero	

Not only are all tests described but relevant notes are included. Here are two, picked at random and copied word for word:

(1) "Examination of pivots and bearings for evidence of corrosion, damage from vibration and shock, etc., shall be

Continued on page 246

THE FASTEST Method of BLACK AND WHITE RECORDING . . .



This Alden recorder was specially designed to produce facsimiles up to 8" width.

ALDEN
FACSIMILE RECORDERS

These complete terminal recording units reproduce typed matter, charts, maps, pictures, fingerprints, writing or text of any sort. Speeds of 48 square inches or more per minute are within the recording capabilities of the paper and equipment. Reproduction is crisp and clean and operation of the machine is simple and trouble-free.

Alden facsimile recorders are designed in conjunction with Faximilie, Inc., engineers, and built by Alden Products Company. They are based on the *John V. L. Hogan* system, that is proving highly successful on transcontinental and international press circuits.

Alden recorders are built to meet your requirements of speed, width of recording, size and operation with other equipment, or to meet the characteristics of any wire or radio circuit.

Write for booklet D, *"The Last Word on Facsimile and Electrolytic Recording"*.

ALDEN PRODUCTS CO. INC.

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EMBY Instrument Rectifiers have specially treated metal electrodes and use the uni-polar conductivity of metal to selenium junction. Rectification is instantaneous—no warm-up period required. No moving parts. Shock-proof. Permanent characteristics. Unlimited life. Increased efficiency with increased temperature. Temperature range, —70 to +70° C. Unaffected by severe atmospheric conditions. Sealed-off units supplied for aircraft service. Series "N" and "S" have satisfactory frequency characteristics and can be used in the frequency range up to 100 kc.

N-2 Input 5 volts. Half wave. Continuous dc current 1 ma. Used with meters, detector circuits, bias voltage.

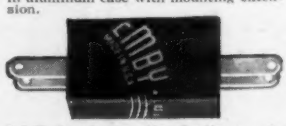
H-SM Input 5 volts. Half wave. Continuous direct current 8 ma. Numerous applications.

B-SM Input and output same as H-SM, but has two rectifying elements connected in series.

DS Input 10 volts. Full wave Bridge. Continuous dc 10 ma. Unbreakable plastic case with mounting extension.

CENSORED Input 10 volts. Full wave. Continuous dc rating 35 ma. Mounted in

DL Input 10 volts. Full wave Bridge. Continuous dc rating 35 ma. Mounted in aluminum case with mounting extension.



P-1-M Input 10 volts. Continuous dc rating 50 ma. Mounting extension available if specified.

CENSORED Input 10 volts. Continuous output rating 80 ma. Designed for

ALL ILLUSTRATIONS ACTUAL SIZE—Send for Bulletin with complete specifications. (Bulletin No. 10 on Self-generating Photo-Electric Cells is also available.)

SELENIUM CORP. OF AMERICA

Manufacturers of EMBY Rectifiers, Photo-Electric Cells and allied scientific products 1-4

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EVERYBODY EVERY PAYDAY 10% IN WAR BONDS

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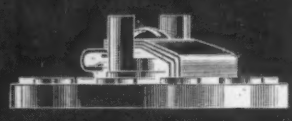
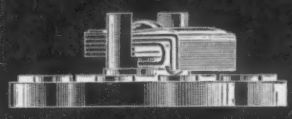
1. Has the highest conductivity of materials available.
2. Is superior to silver-plating which wears off, resulting in high resistance contacts.
3. Should it corrode the sulphide formed does not appreciably increase the contact resistance.

Let Shallcross answer your switch problems
Address Dept. C 16

WHY "SHORTING" AND "NON-SHORTING" SWITCHES?

This is the shorting type. As the arm is rotated from one position to another the adjacent contact points are "shorted" (bridged).





This is the non-shorting type. As the arm is rotated from one position to another, the arm lifts up, and only one contact is touched at a time.

Creators and Makers of

ACCURATE RESISTORS—SWITCHES—SPECIAL EQUIPMENT AND SPECIAL MEASURING APPARATUS FOR PRODUCTION AND ROUTINE TESTING OF ELECTRICAL EQUIPMENT ON MILITARY AIRCRAFT . . . SHIPS . . . VEHICLES . . . ARMAMENT . . . AND WEAPONS

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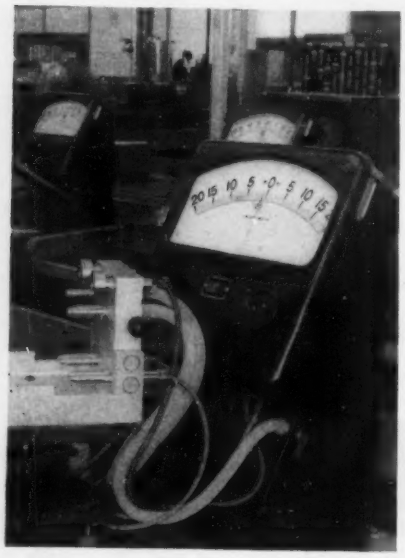
CLAROSTAT MFG. CO., Inc. · 285-7 N. 6th St., Brooklyn, N. Y.

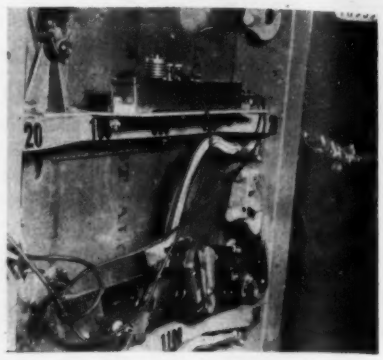
Instruments in the War Effort

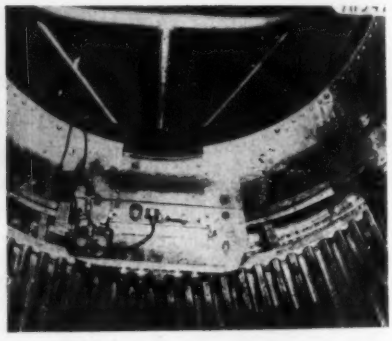
Now It Can Be Told: Plant Is Sperry Gyro

IN our January issue, pages 30-31, we ran an article by Frederic I. Lackens entitled "New Type of Pressure Gage Triples Testing Speed." This article gave usefully-suggestive



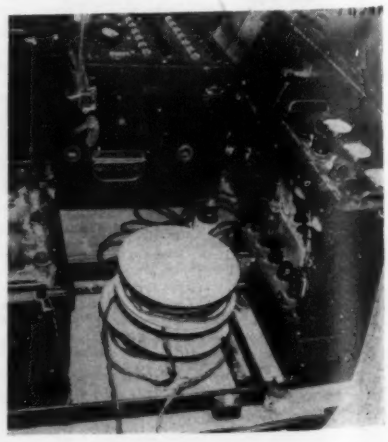
technical details but was not illustrated and did not name the war plant where this "Speeding War Work" idea is giving such good results. Now we are permitted to report that it is the Cleveland plant of the Sperry Gyroscope Co. Moreover, here's a close-up of the gage and of the test fixture, so that the idea may promptly be put to use wherever it can save precious man-hours.





Army Air Forces Measure Strains on Test Flights

IF you have ever seen a fighter twist, turn and dive, you may have wondered how it is possible to build planes that can withstand the terrific stresses of power dives. Did you ever put your hand out the window of a car going 50 miles an hour? At 500 m.p.h. the wind pressure is a hundred times as great, which means that those gleaming American "wings of victory" must have tremendous strength. And the U. S. Army Air Forces must be dead sure they have that strength. The three U. S. Army Air Forces photographs reproduced here (received by *Instruments* from the General Electric Co.) show details of the GE strain-measuring instrumentation. USAAF photo No. 78939 shows an electromagnetic type acceleration pick-up mounted in the fuselage bomb bay of a plane. No. 78942 shows another electromagnetic accelerometer element mounted in the tail structure of a plane. No. 78940 shows a 14-element electromagnetic oscillograph which produces permanent records on a moving photographic film,



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The advancement of electronics has meant wider use of Ohmite Rheostats and Resistors . . . in science and industry, in laboratories, products and production. Engineers, scientists and manufacturers have come to know and rely on them for accurate, dependable control of electronic tubes and devices . . . from x-ray to radio and television, from instruments and machines to airplanes. These time-proved resistance units insure *permanent performance.*

Today, of course, Ohmite Rheostats and Resistors serve the Armed Forces and Industry in combat, production and research in an all-out effort to speed Victory. The electronic world of tomorrow will find Ohmite units ready to meet new requirements and Ohmite Engineers ready to help you on any problem.

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together with its battery power supply, amplifier, power unit, etc. This permits simultaneous recording of the outputs of fourteen strain gages, accelerometers and other electromagnetic type pick-ups located in various parts of the plane during a test flight.

Precision Measuring Instruments for Individuals

WASHINGTON, March 26 (WPB rel. 2967).—A provision making it easier for machinists and other workers to obtain new gages and precision measuring hand tools needed in their employment is an important feature of General Preference Order E-5-a, issued today by the War Production Board.

Workers heretofore have found it difficult to obtain hand tools on the A-10 rating permitted them. E-5-a covers the distribution of new gages and precision measuring hand tools such as micrometers, verniers, calipers and other precision tools and measuring devices used in industrial production, whether sold to the manufacturer or to the individual employee.

E-5-a assigns a preference rating to individual workers who require precision tools on their jobs. Their preference rating is the same as that assigned by CMP Regulations to their employers for maintenance, repair and operating supplies. For example, an employee of an ammunition plant would be entitled to use a rating of AA-1 on an order for a tool of this type required in his job, since that rating is assigned to ammunition plant's maintenance orders by Schedule I of CMP Regulation No. 5. Precision tools may be purchased in this way only on a preference rating of AA-2X or higher and must be accompanied by a certification of the worker and his employer to the effect that the tool is required and that the worker does not own a similar tool capable of use in his employment. This rating provision becomes effective immediately; other provisions of the order on May 1, 1943.

Johns Hopkins Teaching Use of Industry Controls

BALTIMORE, April 10—Automatic control of industrial processes is such an important factor in the war production program that Johns Hopkins University has established a special course to train technicians in the use of industrial instruments and controls. The Brown Instrument division of the Minneapolis-Honeywell Regulator Company is coöperating in the educational program by assigning, as guest lecturers, members of its Philadelphia technical staff. They will explain the working of such instruments as the

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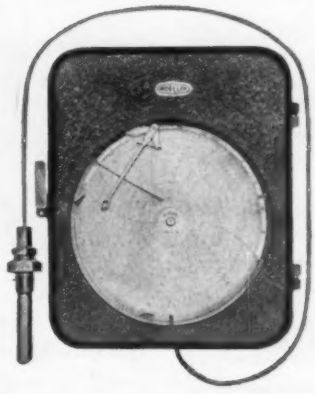

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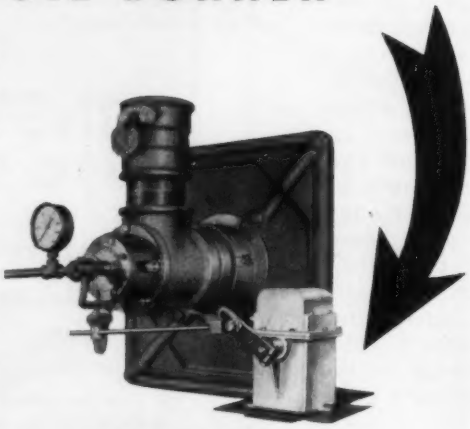
These POWER UNITS are ideally suited for industrial applications. They feature built-in limit switches and a high torque motor with gear reduction, oil submerged, for long life and dependable operation. Control action may be governed by a recording and indicating controller or other contact making control instruments. POWER UNITS are available for "on-off", floating, and proportioning modes of control, including proportioning with manual or automatic resetting.



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"POWER UNITS"

BARBER-COLMAN COMPANY 1202 ROCK STREET ROCKFORD, ILLINOIS

Interval Timers

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Write

AUTOMATIC ELECTRIC MANUFACTURING CO.
MANKATO, MINNESOTA

Protection against fuse failure by crystallizing and cracking is *efficiently* provided by the NEW Littelfuse "Gooseneck" of

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Spring forming at end of element instantly takes up expansion and contraction of sudden temperature changes. (See illustration.) One of many NEW exclusive Littelfuse features for long life dependable service under severest conditions.

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229 ONG ST., EL MONTE (Los Angeles suburb) Calif.

recently-developed electric potentiometer, the Radiamatic pyrometer and air-operated process controllers. Sixty picked men from war plants in this area are attending the classes, which are under the direction of Dr. R. B. Anderson and which include both lectures and laboratory instruction in the principles of temperature measurement and use and maintenance of control instruments.

Heart Specialists Now Use Sound-frequency Analyzer

ORIGINALLY designed by Western Electric Co. for industrial use, a rapid-recording sound frequency analyzer is being used by the medical profession and is opening a new approach to the study of faulty heart action. (A detailed technical description of this equipment, the "RA281," appeared in *Instruments*, June 1939, page 153. It consists of four units: a frequency analyzer, a sweeping drive, a level recorder and a moving-coil microphone or moving-coil vibration pick-up.)

The medical profession became interested in the RA-281 after company physicians in an explosives plant turned to it as a possible method of measuring the heart-muscle fatigue of workers in one department, who were unavoidably exposed to chemical fumes affecting the heart muscles. When that fatigue reached a certain point it induced fainting. The medical problem: to devise a positive method of determining the point at which heart-muscle fatigue would bring about fainting; circumvent a possible explosion that might injure a number of men and wreck the plant if a worker fainted while handling explosive elements. The use of stethoscopes was unsatisfactory because the human element—the doctor's interpretation of the sounds—was too great.

By using three filters, plant physicians found that they could chart the heart sounds of a worker before his exposure to the chemical fumes. These charts were compared with similar charts taken of the heart sounds of workers who had fainted from the fumes. By a regular check-up on all workers in the department and comparison of their charts with those showing the characteristics associated with fainting, company physicians have been able to prevent further fainting. Workers whose charts show muscular fatigue are immediately transferred to other departments.

How effectively and to what extent the RA-281 may be applied to the study of "heart cases" remains to be determined. At present, however, it has been learned that this analyzer-recorder may be used in conjunction with the electrocardiograph. This combination enables physicians to determine what part of the heart cycle is responsible for any abnormal heart action.

SENSITIVITY ± .1°F. MANY TYPES AVAILABLE
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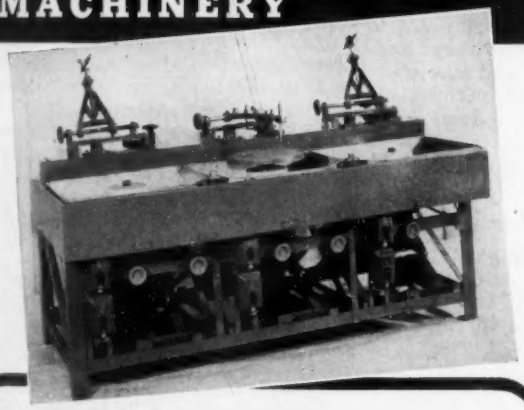
PRECISION OPTICAL MACHINERY



- **8-SPINDLE SHORT RADIUS AUTOMATIC POLISHING MACHINES**
- **1, 2, 3 & 4 SPINDLE AUTOMATIC POLISHING MACHINES**
  Capacity up to 16″ Laps.
- **OPTICAL GRINDING MACHINES**
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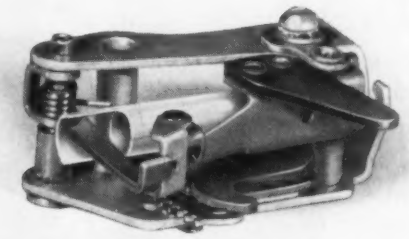
CHACE *Manganese* ALLOY *No. 772*

High Thermal Expansion

The exceptionally high thermal expansion of Chace Manganese Alloy No. 772 is making possible unusual differential expansion designs, such as illustrated here:



This relay, designed to provide overload protection for a-c and d-c motors, includes, in addition to the temperature sensitive element illustrated, a contact element, a heating element, and a supporting enclosure. Heat provided by the motor current is radiated to the No. 772 alloy tube from a heater inserted in the tube. With a rise in temperature the manganese alloy tube elongates, and when elongation reaches a pre-determined amount, a latch is tripped, allowing the relay contacts to operate.

This alloy has the following additional useful engineering properties:

High Electrical Resistivity
1050 ohms per CMF

Low Thermal Conductivity
2% of value for copper

High Vibration Damping Constant
40 times higher than for steel

Now available in the form of sheets, strips and rod, and in special shapes on request.

Send for "Bulletin No. A-942" for detailed information on physical properties of Chace Manganese Alloy No. 772.

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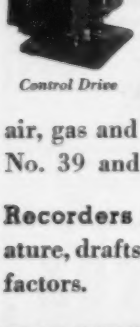
Process Control for sensitive, stable automatic control of temperature, pressure, liquid level, flow and other factors as applied to industrial processes. Responds to changes quickly, without overtravel or hunting. Ask for Bulletin No. 101.

Combustion Control that is simple but *complete* for providing economical operation of boilers of 200 h. p. and larger. Details in Bulletin No. 102.

Recorder-Controller

Boiler Meters for recording combustion conditions and guiding boiler operators. Described in Bulletin No. 44.

Multi-Pointer Gages for indicating factors such as draft, pressure, temperature and speed. These Gages are available with any number of pointers and any scale combination; in either the oil sealed bell or diaphragm construction.



Control Drive

Flow Meters for indicating, recording and integrating the flow of steam, water, sewage, air, gas and other fluids. Bulletins No. 39 and 300.

Recorders for pressure, temperature, drafts, liquid level and other factors.

G-3

BAILEY METER COMPANY

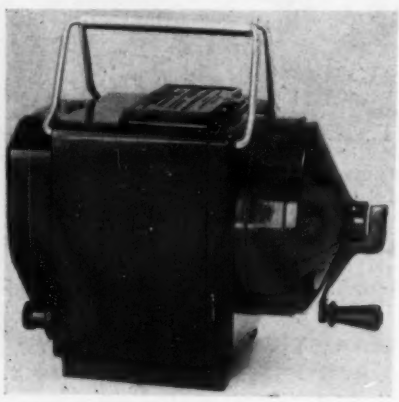
1041 Ivanhoe Rd., Cleveland, Ohio

The Month's NEW INSTRUMENTS

In this department we strive to report each month ALL the new devices for measurement, inspection, testing, metering and automatic control—in the form of concise technical descriptions. When writing to manufacturers directly, please mention this department. Or write to Information Section, Instruments Publishing Company.

Insulation Testers

New U.S.A.-made "Megger" instruments, for testing electrical insulation resistance, are of hand-generator and direct-reading ohmmeter type, technical descriptions of which have appeared



in *Instruments* (most recent description in August 1941, pages 234-236.) They are housed in molded cases of high-impact-strength thermosetting phenolic plastic material; all joints dust-proof and practically splash-proof. They are announced for delivery as soon as customer's priority and maker's expanding production will permit.—*James G. Biddle Co., 1211-13 Arch St., Philadelphia, Pa.*

Height Finder

New "Model CW Teleheight" is a pocket instrument for determining heights of buildings, poles, trees, etc. The leveling tube being at 45° to the

sighting 'scope, observer simply walks to point where top of object is centered in main field of view and bubble is centered on hairline in reflected image of level; then he measures distance to base of object and adds his own eye-height to obtain unknown height.—*W. N. Matthews Corp., St. Louis, Mo.*

Megohm Decade Box

New "No. 915-A Megohm Decade Box" consists of ten 1.0 megohm resistors, connected in series, mounted on steatite insulators. Resistors are thoroughly impregnated so that calibration

is not affected by high humidity. Each resistor is capable of dissipating two watts; however, in work requiring closer tolerance, dissipation should be held to one watt per unit. Resistors have a standard accuracy of ±0.05% at 74°F. Unit may be immersed in an oil bath for work demanding extreme accuracies, increased dissipation or both; is housed in a metal box, may be furnished completely shielded. A maximum of 10,000 volts may be applied across binding posts. Maker's standard 2- and 4-dial resistance boxes may now be secured with all of the advantages of this new instrument.—*Shallcross Mfg. Co., Collingdale, Pa.*

Instrument Cleaning and Rinsing Compounds

New "C1-S" visual-indicating compound has been developed especially for cleaning instruments, jewels, switches and delicate metal parts. When most efficient it is blue; as it is used it changes color until it is red—at which plainly-observed point it should be discarded. The final stages of the color are unmistakable. Also announced is "R2" rinsing compound, likewise developed for instruments and fine mechanism, which is a "final" rinse: parts can be dried in air without fear of harmful non-evaporable film.—*The Odell Co., Inc., 230 Wright St., Newark, N. J.*

Redesigned Thermometer

New brassed-steel case glass thermometer is said to be "an entirely new thermometer incorporating every new improvement heretofore added to existing glass thermometers, plus many new improvements." Originally designed as a means of conserving critical copper used in cast bronze cases, it is said to be "a tremendous forward advance in the manufacture of industrial thermometers." Among new features are: (1) Redesigned by one of foremost industrial designers. (2) So made that it is possible to furnish back, side and oblique angles without ball joint. (3) Scales and tubes located in a manner which produces greatest readability. (4) A new method of making scale has been developed which is said to produce "a more legible and better looking scale than has ever been available before." (5) Case has been reinforced to give it "all the structural stiffness of a plate girder." (6) Screw which holds cover has been attached so it can "never" come loose and be lost. (7) Case is practically corrosion-proof: black suede finish showed no corrosion after 100-hour salt spray test. (8) Scale is black with yellow figures; tube is red-reading mercury. (9) Weight is approx. ⅛ less than present standard glass thermometer of same size. New instrument meets fully Navy specification 18-T-7. — *American Schaeffer & Budenberg Div. of Manning, Maxwell & Moore, Bridgeport, Conn.*

Combustion Efficiency Calculator

New "Fire Efficiency Finder," for use with maker's portable "Fyrite" CO_2 Orsat Analyzer, is a calculator that converts CO_2 and stack temperature readings into heat loss and heating efficiency percentages. When the CO_2 percentage in the flue gas is determined with the "Fyrite" Orsat, the pointer in the calculator is moved to the corresponding figure on the scale. Then the slide is moved until the figure obtained by testing stack temperature shows in the upper right-hand corner. As a result, the performance of the furnace appears in the slotted arrow—one figure showing percent of heating efficiency, the other the percent of total heat loss. The "Fire Efficiency Finder" together with the "Fyrite" offers the power engineer a simplified, quick way to determine furnace performance since a complete CO_2 test can be made in 40 seconds with the Orsat, and the calculator instantly converts the reading into terms that show the degree of furnace efficiency. — *Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.*

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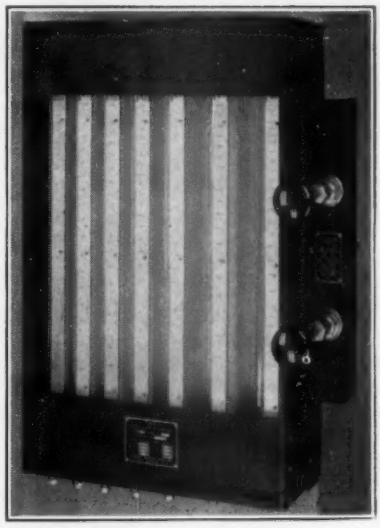

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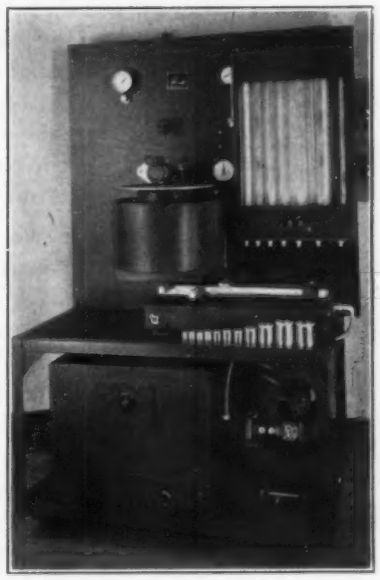

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Used in engine plants for calibrating rate-of-flow indicators

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NOW DEVOTED ENTIRELY TO DEFENSE WORK

MODEL RTC-1 Mechanical Refrigeration; Temperature Range: —55° F. to +70° C. Usable Interior: 28.7 cu. ft.

The AMCOIL Test Chamber can simulate conditions of the upper altitudes and their effect upon the operation of your delicate precision instruments . . . thus insuring compliance with high and low temperature specifications.

TEST *in advance* the behavior of your instruments under extremes of *low* and *high* temperatures – the effect of sub-stratospheric temperatures and pressures—by using AMCOIL Test Chambers. These are completely automatic temperature test chambers combining mechanical refrigeration, electric heating, and having an unusually fast rate of temperature change.

Model RTC-1A thermostatically controls low and high temperature ranges from —70° C. to +70° C. (—95° F. to +160° F.), and has a *usable* interior of 25 cubic feet. Entire operation is controlled from front panel board. Five thicknesses of glass, hermetically sealed and dehydrated to prevent condensation, permit clear observation of instruments during test.

Other AMCOIL Models with either mechanical or dry ice refrigeration, in various sizes, and special chambers are available. Ask AMCOIL engineers to advise you on the correct type of AMCOIL Chamber for your tests.

FOR HUMIDITY CONTROL . . . an individual unit is easily attached to any AMCOIL Temperature Test Chamber.

FOR ALTITUDE TESTING . . . special chambers are provided.

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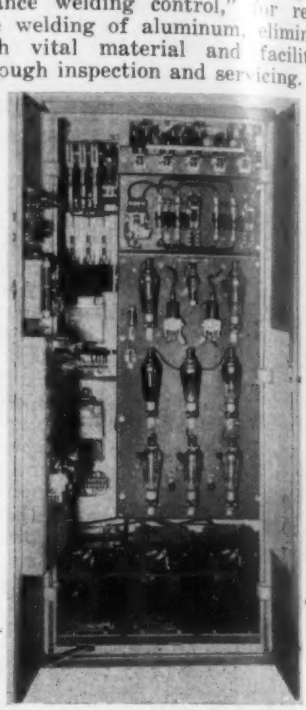
3719

Controller for Resistance Welding of Aluminum

Greatly simplified construction of new "electronic capacitor discharge resistance welding control," for resistance welding of aluminum, eliminates much vital material and facilitates thorough inspection and servicing. Employing energy-storage principle, new controller provides the high currents and short welding time required for satisfactory resistance welding of aluminum. Controller consists of a charging circuit, a discharge circuit, control station, Pyranol capacitors and sequence controller, all mounted in maker's cabinet-type industrial control enclosure with full-length front doors and removable rear covers. Enclosure is ventilated by filtered air drawn in by a blower: pressure within cabinet minimizes infiltration of dust and dirt. Main anode transformer and all tubes requiring cooling are air-cooled by a ductless system. Charging- and discharge-tube circuits are mounted on a single hinged compound base that can be swung out readily for servicing. Control station—consisting of the capacitor selector switch, voltage adjusting potentiometer, sequence adjusters, voltmeter, control switches and indicating lights—can be removed from the cabinet and attached to the welding machine. Thus, cabinet can be located on a balcony or other remote point, conserving valuable factory space. Also, wiring between the various panels and the control station is brought to a centralized terminal board, facilitating checking of circuits.—*General Electric Co., Schenectady, N. Y.*

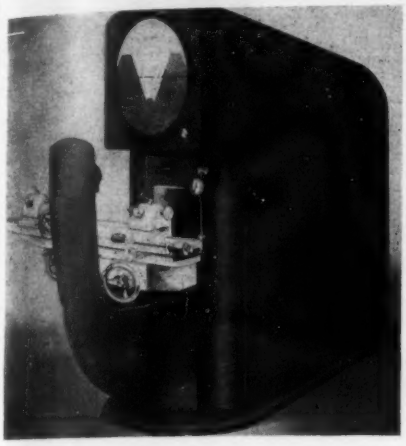


Plug-in Type Capacitors

New plug-in type of "Dry Electrolytic Condenser" is recommended for elimination of low-frequency ripple (2—100 cycles), can be sealed as well as any capacitor, is said to be able to take such abuse and deliver such long life that manufacturer considers it entirely practical to solder or weld it into units.—*Sprague Specialties Co., North Adams, Mass.*

Universal Optical Comparator

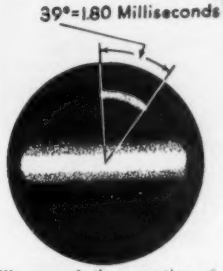
New "Model P-3 Universal Optical Comparator" covers a wider range of work and is said to incorporate a scientifically correct optical lens system. It can handle parts of sizes heretofore considered beyond the range of optical inspection apparatus. Exceptionally wide field of objective lens units in conjunction with superior light obtained with the microphotographic bulb makes it possible to project large images having sharp outline definition and uni-



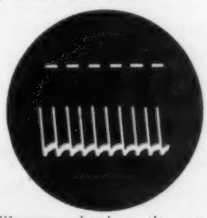
form light over entire screen area. Lens units are available to provide magnifications for 10×, 25×, 31¼×, 50×, 62½× and 100×. Special lens units having higher magnifications can also be obtained. Comparator is of exceptionally rugged construction — a feature of importance where there is vibration. Universal type stage enables operator to place work in various positions and offers flexibility of movement in all directions. Stage travel measurement control devices permit precise readings to 0.0001″ over entire range, are included as standard equipment and take care of readings in all directions. A graduated protractor screen is also included as standard equipment. Mechanical specifications: Distance between centers 12½″. Vertical measuring range 8″. Horizontal measuring range 8″. Work screen diameter 18″. Vernier reading on screen 360°. Work table dimensions 6″ × 24″. Angular setting of stage to 22°. Height 72″, width 34″, depth 72″. Approx. shipping weight 1500 lbs. Extra accessory equipment available includes adjustable center supports, surface illuminators, and right angle work holder. —*Portman Machine Tool Co., 17 & 19 Beechwood Ave., Mount Vernon, N. Y.*

Safety Extension Light

New safety extension light is said to be absolutely safe against electric shock, even when the guard is removed. Guard is of heavy fibre. New type of spring contact is exclusive with maker. Light is so designed that the guard serves as the on-and-off switch: when it is unscrewed the current is automatically cut off. Light is said to be made of indestructible materials. "Entire device is made of non-conductive materials." Bulbs are replaced quickly since guard is removed without use of tools. — *Davis Emergency Equipment Co., 45 Halleck St., Newark, N. J.*



Oscillogram of the operation of a two-way snap-switch, accurately timed in milliseconds. The segment represented by the curved trace or arc, measured 39°, or the equivalent of 1.8 milliseconds.



Oscillogram showing the precise wave form of the DuMont Variable-Frequency Stimulator for brain surgery and research. The remarkable uniformity of wave form and amplitude of the stimuli, is clearly disclosed here. Time interval: 1 millisecond.

Oscillogram of the response of a given amplifier to a 100 kilocycle square-wave signal. Such electronic writing provides the best evidence of actual performance.

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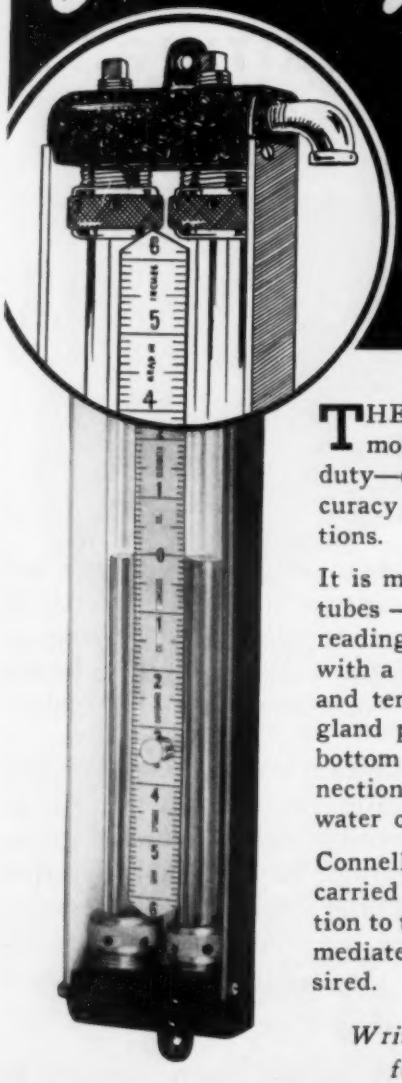

THE New Connelly Manometer, model 3400—built for extra heavy duty—can be depended upon for accuracy and long life under all conditions.

It is made with large bore, clear glass tubes — ¾" in diameter — for easier reading even at a distance. Supplied with a scale graduated either in inches and tenths or in metric measure. It is gland packed, with drain plugs at the bottom and is fitted for ⅛" pipe connections. Made for use with either water or special anti-freeze solution.

Connelly Model 3400 Manometers are carried in stock in five sizes. In addition to these stock sizes, larger or intermediate sizes can be supplied if desired.

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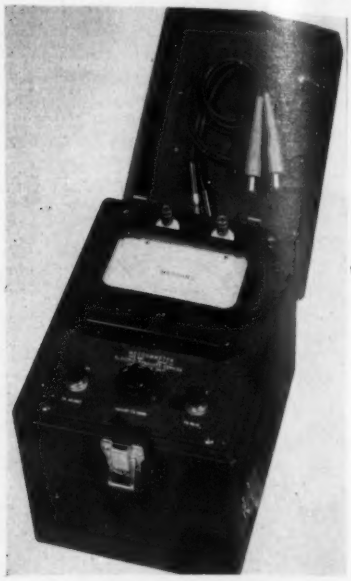
Resistance Tester

New Cole Megohmeter was developed to provide a moderately-priced convenient portable unit. It weighs 15 lbs. complete with leads in lid compartment, is battery-operated. Dimensions, 9⅝" long, 6½" wide, 8¾" high. Indicator has a scale length of 3¾". Standard model scale is graduated and calibrated 0 to 200 meghoms with 400 volts d.c. at test terminals. Energy supply is from two standard 3-volt dry cells which are even now readily obtainable. Battery life is little more than shelf deterioration as the current drawn is extremely small, battery being in use only when readings are taken. Cells are replaced through hinged door on side of case. Operation is extremely simple as it requires only the depression of the push button: one operator unaided can take readings. Other models can be made to order with different applied potentials, also different megohm ranges. —*Electric Products Service, 1322 S. Grand Ave., Los Angeles, Calif.*



Communication System with Interceptor Control

New "Executive-Monitor" communication system consists of two or more master stations connecting up to 19 remote stations. Executive and Monitor stations can talk to each other, or either can carry on two-way amplified voice conversations with remote desk or trumpet-type substations. New Interceptor-Control feature enables assistant at Monitor station to intercept all incoming calls originating at remote

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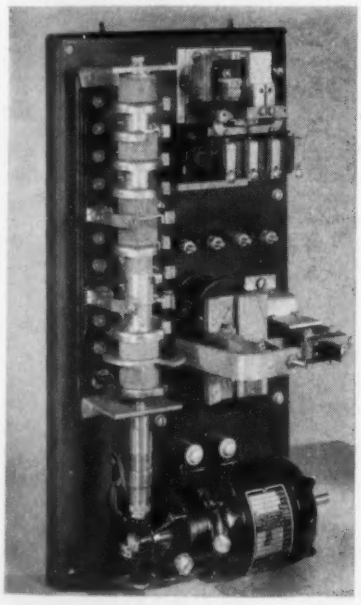
stations. Assistant receives and sifts these calls and, at his discretion, can transfer to chief executive important calls requiring executive attention. Both Executive and Monitor stations are equipped with busy signals to show when other stations are in use. Executive station, however, has optional facility of Right-of-Way over busy stations for emergency use. A paging button enables user of any master station to call all other stations simultaneously. Persons called can reply remotely without leaving their work to approach station. Push-button selection speeds operation. System operates on 110-120 volts a.c. or d.c., consumes 46 watts, is UL approved, licensed under A T & T patents, installed and serviced by maker's own representatives in principal cities. —*Executone, Inc., 415 Lexington Ave., New York City.*

Synchronous Motor Starting Relay

New "STA Synchromatic Relay" for field application is said to make possible more satisfactory synchronous motor starting. It consists of two elements, one speed-responsive (a current relay) and the other time-responsive (a rotary drum switch). Both are said



to be simple in design, rugged and trouble-free in construction and needing no critical adjustments. Synchromatic Relay is said to meet all six basic requirements for synchronous motor control: (1) maximum nonsynchronous speed attained before field application, (2) minimum power required because synchronizing is never attempted before maximum speed is attained, (3) synchronizes in minimum time consistent with maximum speed, (4) positive synchronizing sequence, (5) minimum line disturbance because of favorable rotor position and (6) automatic pull-out protection. It is compactly designed either for panel mounting or modern dead-front metal-enclosed swing-door type control structure. — *Department 7-N-20, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.*

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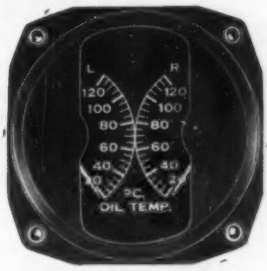

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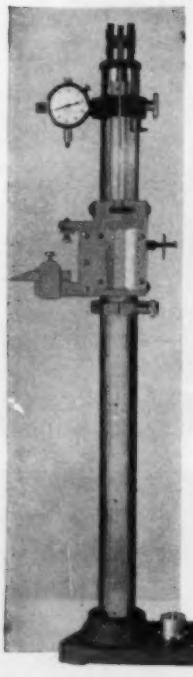

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For use on the surface plate or layout table

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Vernier with scale permits direct reading to .001". Accuracy of dividing ±.0002". Equipped with dial indicator of .0001" reading.

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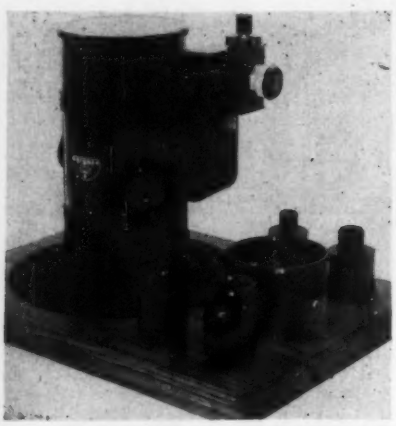
Spherometer

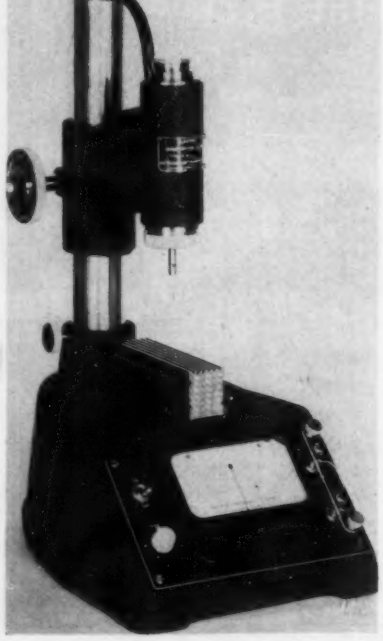
New Spherometer is of the Abbé type, measuring difference of sagitta of a known plane surface and unknown sphere. Instrument is supplied with six rings which allow the surface to be tested on three points of contact. These are approximately 10 mm., 15 mm., 20 mm., 50 mm., 75 mm. in diameter. Optical flat for zero setting is supplied. Plunger is counterbalanced to give



constant pressure on all readings to insure accuracy. Sagittal measurement is accomplished by reading the scale divided by $2\frac{1}{10}$ mm. with a micrometer eyepiece. (It can be read directly to 0.001 mm. with fifths readily estimated.) Scale is illuminated by transmitted light and read with microscope magnification. Microscope tube length is conveniently shortened by inclusion of prisms. — *International Industries, Inc., Ann Arbor, Mich.*

Electric Comparator

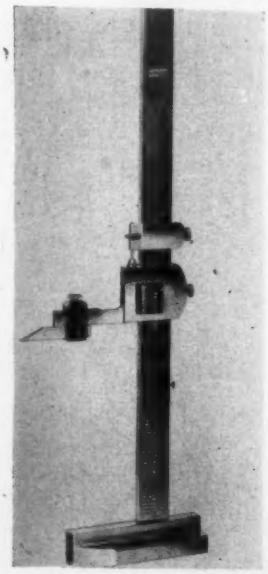
New "Type 1A" four-range electric comparator, for rapid comparison of close-tolerance machined parts, selective sorting of machined parts, etc., eliminates the human element of "feel," can be set to size in less than twenty seconds using a master part or gage



block. When production part to be compared with master is placed on anvil under spindle, its deviation is indicated. Features: (1) Four ranges of sensitivity: ±0.0002", ±0.0004", ±0.002", ±0.004". (Magnifications of 10,000, 5,000, 1,000, and 500 respectively.) Metric scales, or special scales with higher magnifications and wider ranges can be provided. (2) Spindle pressure variable from 2 oz. to 2 lbs. (3) Gage head swivels around column and tilts at any angle to vertical. Angle indicated on protractor. (4) To permit setting to size in less than 20 seconds, three size adjustments are provided: rack-and-pinion elevating mechanism, vernier adjusting collar on gage head and electrical zero adjustment on indicating unit. (5) Gage head and indicating unit easily removable from stand for use in special set-ups or in multiple gage fixtures. When thus used, knurled collar at bottom of gage head serves as a vernier size adjustment.— *Metron Instrument Co., 432 Lincoln St., Denver, Colo.*

Vernier Height Gages

New vernier height gages, available in three standard sizes, 12", 18", and 24", English or Metric measure, are designed especially for use in jig and

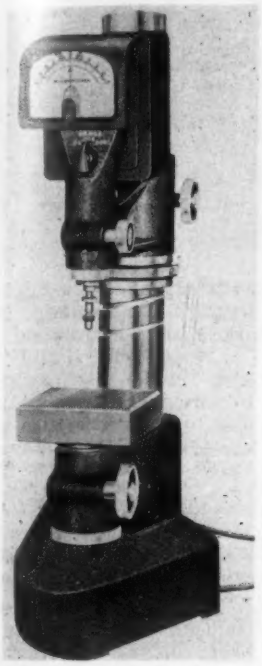


fixture making and for general layout and inspection work. Exceptional precision is said to enter into their calibration, making these gages valuable adjuncts to gage blocks in angle measurement, etc., where unusual accuracy is required.—*Jansson Gage Co., 19208 Glendale Ave., Detroit, Mich.*

Electric Comparator

New "Model 11 Micrometron" is said to be "an entirely new type of gage." It is a triple-purpose instrument with ranges of ±0-0.05", ±0-0.005" and ±0-0.0005" which can be selected instantly by a selector knob. This feature makes instrument usable for ordinary shop work and in a moment convertible for indicating differences as small as 0.00002". There are no delicate mechanical adjustments. Unit is said to be "basically an electronic type." To oper-

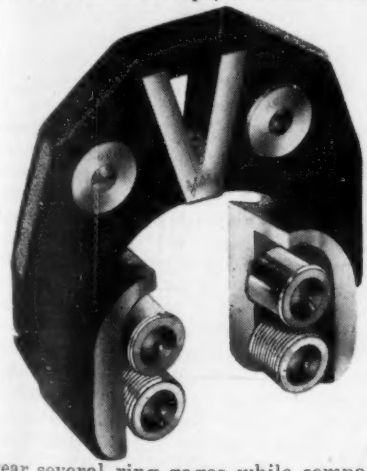
ate, a st[illegible]ard workpiece is inserted under an[illegible]nit is positioned to read zero. Tes[illegible]ieces are then inserted in place of [illegible] standard and the differences are [illegible]ndicated on the 4" scale. Large sc[illegible] makes it possible for an operator [illegible] be a considerable distance from inst[illegible]ment. An anti-parallax lens



and pointer are featured. Unit operates from 105-120-volt 60-cycle power supply, is not affected by line voltage changes, is immediately usable by technical or shop personnel. Diameters as large as 8" can be checked. Hardened steel table is 4" square. Available on priority only.—*Televiso Products, Inc., 6533 Olmsted Ave., Chicago, Ill.*

Thread Gages

New models of "Improved Vard Thread Roll Snap Gage" have strengthened frames and convenient machine pads for bench set-ups, are said to out-



wear several ring gages while comparing favorably in cost with ring gages (less costly in larger sizes). This type of gage not only checks pitch diameter and thread form angle but checks the lead and can be used flat against a working shoulder. Precision tool-steel rolls are fitted with eccentric pins for correct adjustment to size. Pins compensate for wear and permit tolerances changes. New gages are available in all pitches, English or Metric, right- or left-hand, for all classes of fit. They are made with two lengths of roll: "Model O-A" ½"; "Model O-B" ¾". ("Model O-C" for No. 12 and smaller has rolls 5/16" in length.) Setting plugs are available in all sizes from No. 4 to 1½" in standard pitches.—*Vard, Inc., Pasadena, Calif.*

External Comparator Stand

New external comparator stand weighs 30 lbs., is cast from a special fine-grained iron. It is slow to react to temperature changes and is heavy enough to stand up under heavy usage. Slide, likewise of cast iron, will hold almost any standard make dial gage or maker's own mercury-column indicator, travels on a fast-acting, precision-ground Acme thread, and slides on hand-scraped ways machined out of the casting. It is equipped with two lock screws to hold it in set position after initial setting with gage blocks. Large knurled set screw in base permits quick change of working tables when necessary. These tables are machined and hand scraped to flatness. A ground fit with the base casting insures accuracy in position when working. Tables are made in the following dimensions: 4" circle; 6" × 6"; 6" × 12".—*Vard Inc., Pasadena, Calif.*

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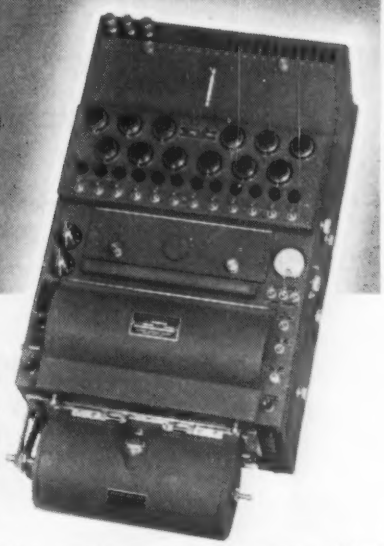
5,000 TIMES A SECOND?



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These thermometers must be made to the same high standards for which Palmer Thermometers are famous because only GOOD thermometers will help to win the war more speedily.

In the meanwhile, REMEMBER Palmer Quality means:

1—Easy-reading "Red-Reading-Mercury"
2—Guaranteed permanent accuracy
3—Constructed for long life.

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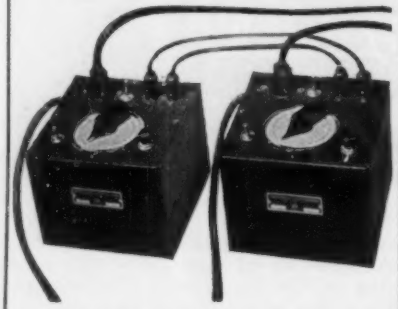
PHOTOVOLT ELECTRONIC TIMER

An adjustable timing relay operating without clockwork or motor.

- High speed timing, from 1/20 sec. up.
- Immediate automatic resetting
- Push button and remote control



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STOKES *High Vacuum* GAUGES

For Quick, Accurate Measurements . . . in Laboratory or Plant

Maintain the efficiency of your vacuum apparatus, pumps, etc. Check vacuum pressures in processing operations. Obtain accurate quantitative readings in your laboratory work.

With Stokes High Vacuum Gauges readings are obtainable in only a few seconds, in rapid succession, without the use of reference vacuums, assisting gauges, batteries or electrical connections . . . as easily as reading an ordinary thermometer.

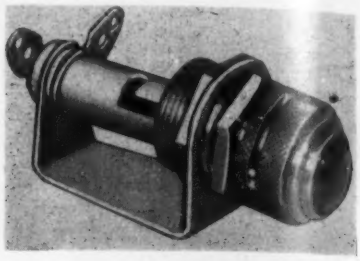
Two models, calibrated for use within the micron and .5 mm. ranges. Portable or permanent mounting. Light weight. Rugged. Write for Bulletin 42-G with complete description, prices, etc.

F. J. STOKES MACHINE CO.

5958 TABOR ROAD, Olney P.O., PHILADELPHIA, PA.

Variable-intensity Shutter Type Pilot Light

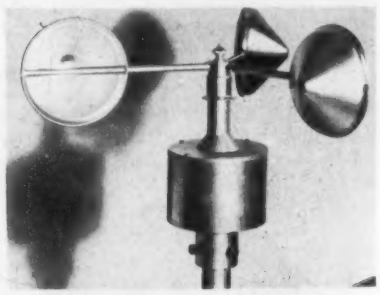
New shutter type pilot light is particularly suited to aircraft, marine, signal and similar applications where various intensities of light are desired under constantly changing conditions.



They permit a gradation of light from bright, through intermediate glows, to total dark with 90° rotation of the shutters. "Model 430" (with faceted jewel) and "Model 431" (with plain jewel) are available with red, green, amber, blue or opal lens, also with polarized lens.—*The Gothard Manufacturing Co., 1300 N. Ninth Street, Springfield, Ill.*

Electric Anemometer

New "Model MV 301 Wind Speed Assembly" consists of anemometer transmitter unit and indicator. *Transmitter unit* comprises a specially-designed cup wheel and a d-c. transmitter generator. Cup wheel speed is directly proportional to linear motion of air up to 100 m.p.h. Armature winding is close-coupled type producing a non-fluctuating voltage at velocities as low as 1.5 m.p.h. Generator design eliminates lower bearing, minimizes friction.



Ball bearings are fitted into upper section of housing thereby keeping radial and thrust load at approximate center of cup wheel arms. Ball bearings grease-seal type and will retain original lubricant for life of bearing. Output voltage is high enough for several indicators to be connected at the same time. Entire generator assembly is fitted into a weatherproof case with mounting end to slip fit over a standard 1" pipe. *Indicator* is standard d-c. voltmeter type, calibrated in m.p.h. Standard scale 0-100 m.p.h. Double-scale ranges can be furnished such as 0-100 m.p.h. and 0-50 m.p.h. Lower scale range can be read by pushing a button or rotary switch. Scale length of standard indicator 6". Indicators can be furnished with scales up to 13"; or with scales calibrated in kilometers per hour; knots; or meters per second. Entire assembly is "fully compensated

for temperature, and will maintain a high degree of accuracy under extreme climatic conditions." Indications can be

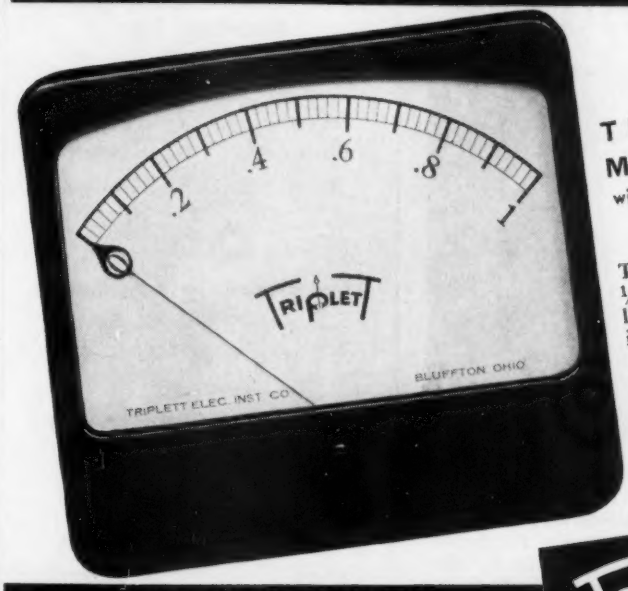
placed 2000 feet from transmitter with no effect on accuracy.—*Electric Speed Indicator Co., 3619 Rocky River Drive, Cleveland, Ohio.*

Signal Light

New "No. 1534 Signalette" signal indicator works in daylight, under ultraviolet light and no light. It was designed for use in aircraft wherever a signal light is used but is said to promise improved indicating service in other fields. Indication is entirely by reflected light and radioactivity. Signalette operates by fluorescence from the usual u-v. sources within aircraft. Radium-active

fluorescent paint shows signals in total darkness. Device uses only 1.5 watts as against approx. 4½ watts used by present lamps. Indication is free from glare in daylight as well as night use. An objection to light-transmitted indicators being that they dim out in bright sunlight, device makes signals correspondingly brighter in the strongest light. Improvement over glass signal lamps is transparent plastic cap "which withstands the most severe tests of shock or explosion" and permits free penetration by ultraviolet rays. Body of Signalette indicator houses a solenoid, the armature of which actuates the "butterfly" indication vanes to show signals, reflecting the proper indicating light. "Butterflies" are furnished in red, amber and green. When not indicating, Signalette is black. Immediate interchangeability with the AC 42B3539 signal indicators. Length overall 2 5/32" for mounting in panels up to ⅜" thickness.—*Littelfuse Inc., 4757 Ravenswood Ave., Chicago, Ill., and El Monte, Calif.*

TRIPLETT
Combat Line INSTRUMENTS



TRIPLETT MODEL 626
with long 5.60" scale

★

This illustration is ½ actual size. Note long scale and minimum panel space required.

A WORD ABOUT DELIVERIES
Naturally deliveries are subject to necessary priority regulations. We urge prompt filing of orders for delivery as expeditiously as may be consistent with America's War effort.

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For Development or
IDEAS
That are Patentable

Ideas for patents suitable to screw machine work are desired by soundly financed precision screw machine manufacturer of high reputation for development now or for post-war period.

Ideas or patents needing development in the following field preferred:

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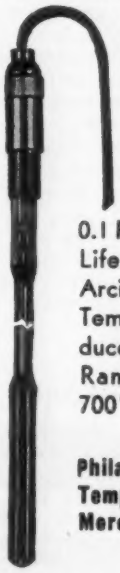
Philadelphia Merc-to-Merc Thermo-Regulators Feature



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The Philadelphia Thermometer Co.
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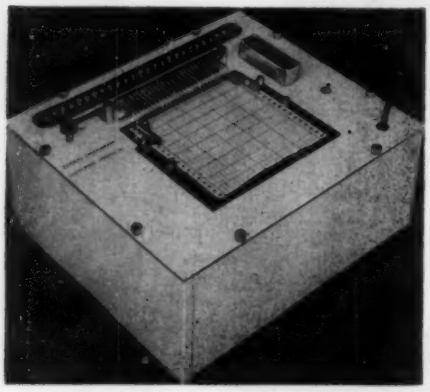
WRITE FOR CATALOGUE No. 104.
Oldest Thermometer Manufacturer in Philadelphia

25-circuit Chronograph

New 25-stylus model of the Garceau Chronograph, for ¾" per hour chart speed, is especially designed for obtaining records of events with relation of the time of day. It is particularly adapted to recording the incidence of alarms in a multiplicity of circuits; actual running time of equipment in a manufacturing plant; indicating and



recording (by connection to a simple push-button system) the attendance of personnel, etc. It utilizes an electrically-sensitive recording paper furnished in perforated charts 7½" wide by approximately 500 ft. long. Rolled chart, contained within the case, is advanced over a sprocket-equipped platen by an electric clock motor at an exactly regulated speed of ¾" per hour. Chart has transverse time lines at 15-minute intervals and hours of day are marked. Longitudinally, chart is divided into 25 numbered channels. Twenty-five styli mark a dense black line when connected through any contact-making system to the high side of the 115-volt lighting circuit, make no trace unless electrically energized. Since a monentary signal would make a dot too minute to detect on cursory inspection, the styli are constantly oscillated transversely at a frequency of one full cycle per 3 seconds and with an amplitude of 3/16" within the boundaries of their marked channels. Thus if a stylus is energized for only one second a transverse mark ⅛" high will appear on the chart. Cabinet dimensions 16" wide × 14" high × 6" deep. Hangers are provided for wall mounting. Steady power consumption is approx. 8 watts at 115-volt 60-cycle a.c. (approx. 5 milliamperes per stylus). Instrument is in production but a preference rating is required with order.—*Electro-Medical Laboratory, Inc., Holliston, Mass.*

Electron Microscope

A simplified electron microscope, described by Dr. C. H. Bachman at Columbia University at a recent joint meeting of Am. Physical Soc. and Am. Soc. for X-Ray and Electron Diffraction, is commercially available. Instrument can be plugged into 110-volt a-c. house circuit, is capable of producing images 10,000 times the size of the subject. Further enlargement can be made photographically up to 100,000×. Explained Dr. Bachman: "The magnifying power of the electron microscope was not selected to attempt an approach to the ultimate, but rather to provide an instrument useful to the solution of immediate war and post-war problems confronting the great majority of workers in this field. It is believed that to these workers, the relative simplicity and ease of operation of the instrument will appeal." New instrument is expected to expand use of electron microscopy in laboratories now engaged in

war work and medical research—and eventually to find wide usage in high schools and colleges. Because of present priority requirements, instrument will be available for use only in essential laboratories and war plants. It has an over-all height of 52" and requires floor space of about two by three feet. Cabinet includes power supply, mechanical vacuum pump and an air-cooled oil-diffusion high-vacuum pump. A camera is provided for mounting in front. Cabinet weighs 600 lbs., is mounted on castors. No special facilities for operating the instrument are needed. Unit includes the microscope proper and all auxiliaries. Microscope has been designed for convenience of operator. Electron chamber is mounted horizontally, eyepiece at one end being at eye level for seated operator. Electron chamber is supplied with voltage and is evacuated from the end which extends into cabinet. All controls are at operator's fingertips. These include accelerating voltage, image intensity, main vacuum valve, focus control and movement of the specimen. In effect, operator is seated at a desk with a drawer beneath so that materials and notebooks are conveniently at hand.—*Radio, Television & Electronic Dep't, General Electric Co., 570 Lexington Ave., New York City.*

Portable Resistometer for Anti-static Surveys

New "No. 11-600 Resistometer" is designed to test the resistance to ground of a human being, machinery or flooring. If resistance to ground is too high, static electricity may build up on the machinery, conductive flooring or operator. Extent of charge depends upon degree of resistance interposed between these bodies and the earth ground. Resistometer is a portable battery-operated unit. It comprises instrument and test stand. When testing individuals, one foot is placed on each plate. The circuit is completed through his two legs and his resistance to ground is indicated directly. Either 1½ volts or 90

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Test Meters Needed For War Service

We need high-quality, portable indicating instruments for the testing of electrical equipment for U. S. Navy. We will buy, or rent for the duration, the following instruments having ¼% accuracy:

A-C Dynamometer-Type Voltmeter, for 0-500 volt service, with or without external resistance box;

Polyphase Power Factor Meter;

Polyphase Wattmeter, 5-10 ampere coils for 500 volts;

D-C Millivoltmeter, 0-100 M.V. scale;

D-C Voltmeter, 0-300 scale.

If any engineering schools have spare instruments to rent, we will guarantee to return them at end of our contract period in good condition or to replace with new instruments of equal quality.

I-T-E Circuit Breaker Co.

501 N. 19th St., Philadelphia, Pa.

RUBICON "SPOTLIGHT" GALVANOMETERS

RUBICON MULTIPLE REFLECTION GALVANOMETERS are available with sensitivities as high as 5×10^{-10} amp. or 1×10^{-6} volt per mm. scale division and with periods as short as 1 second. The scales are 100 mm. long and are remarkably proportional.

Hundreds of these sturdy self-contained galvanometers are in daily use in leading educational and industrial establishments for precision measurements by both the null and the deflection methods. Described in Bulletin 320.

RUBICON COMPANY

ELECTRICAL INSTRUMENT MAKERS

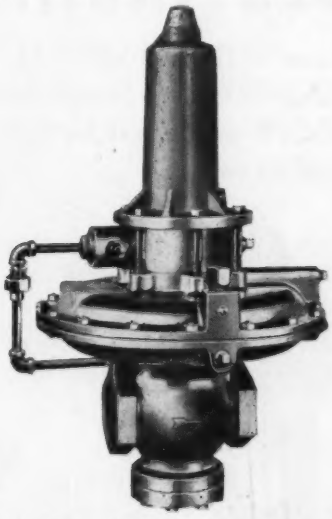
Ridge Ave. at 35th St. Philadelphia, Pa.

volts may be used. However, the circuit is so arranged that no more than one milliampere can flow. Even with a direct short across the two plates, no more than two milliamperes can flow. A safe resistance to ground, when testing an individual by the plate method, is one megohm. This is where the red and green on the scale meet. Two scales are incorporated in the Resist-

ometer. The low scale operates on 1½ volts with a range from 0 to 600 ohms. The high scale operates on 90 volts with a range from 0.1 megohm to 20 megohms. By reason of the safeguards built into the Resistometer, it is said that "you will never be able to cause a spark or an arc" and that the subject being tested can never receive an electric shock.—*Davis Emergency Equipment Co., 45 Halleck St., Newark, N. J.*

Gas-pressure Regulator

Addition of a high-pressure series regulator to present line of "EMCO 1001" gas pressure regulators is announced. New regulator is furnished either for outlet or inlet pressure control, provides an outlet pressure range



up to 60 lbs./in.^{2} maximum, is so designed as to cover the entire span between 5 lbs. and 60 lbs. with the same spring. It is furnished in one size only with 2" threaded connection for standard pipe. Manufacturer states that this regulator can be used to control air, manufactured or natural gas.—*Pittsburgh Equitable Meter Co., 400 N. Lexington Ave., Pittsburgh, Pa.*

PERMANENT MAGNETS

NEW STEELS AND NEW PROCESSING METHODS ARE PRODUCING

BETTER MAGNETS

WITHIN the past few years, rapid progress has been made in the practical application of permanent magnetism. Much more is known about the subject. Designs of magnets have been improved. Better steels are available. Processing is more precise and under better control.

Those interested in the design of permanent magnets or in the selection of magnet steels should investigate ALNICO and NIPERMAG, two recently perfected steels with exceptionally high energy content.

ARMY E NAVY

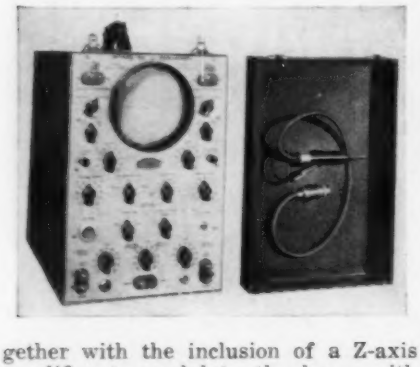
4-C-C-4

CINAUDAGRAPH CORPORATION

STAMFORD, CONNECTICUT

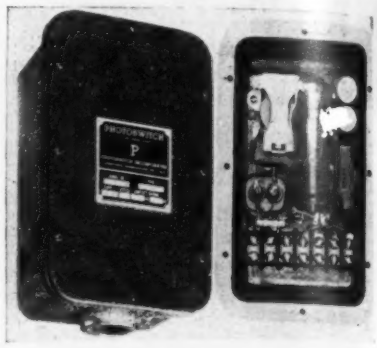
Wide-frequency Cathode-ray Oscillograph

New "Type 241" 5" cathode-ray oscillograph is distinguished from maker's 3" "Type 224" (*Instruments*, Nov. 1942, page 476) by larger screen size together with the inclusion of a Z-axis amplifier to modulate the beam with any signal applied to its input terminals or with a return trace blanking impulse produced by the linear-time-base generator. New oscillograph has a uniform Y-axis or vertical deflection response from 20 c.p.s. to 2 megacycles. It offers a comparably faithful square and sinusoidal wave response. The X-axis or horizontal deflection amplifier has a uniform characteristic from 10 c.p.s. to 100 kilocycles. Both amplifiers have distortionless input attenuators and gain controls. Provision is made to connect signals directly with the deflection plates when frequencies to be observed are beyond useful limits of amplifiers. Black wrinkle-finished case has removable front cover that protects front panel when not in use. Removable test probe, held inside the cover by clips, consists of a compensated 10:1 attenuator mounted in an insulated probe and supplied with a 3' length of coaxial cable and connector. This feature permits connections to relatively high impedance circuits without serious loading, while minimizing stray pickup. Instrument operates on 60-cycle 115-volt a.c., weighs 65 lbs., measures 17½" high, 10¾" wide, 21" deep.—*Allen B. Du Mont Labs., Passaic, N. J.*



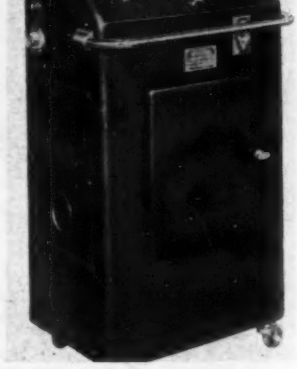
Liquid Level Controllers

New series of electronic level controllers designed for hazardous-location mounting are supplied for use with conductive liquids of an explosive nature. Types "P15NHX" and "P15NLX" are available for high- and low-level control respectively. Each is furnished as a complete unit in a vapor-proof cast-iron housing for direct tank installation. A 1" nipple screws into hub at bottom of control housing, and is screwed into a 1" flange on top of tank. From the control, a probe rod projects through nipple and into tank to desired depth. Probe is supplied as standard in ½" diameter brass. Other metals available. High-level control is accomplished when liquid rises and contacts the probe tip; low-level control, when liquid drops below the probe tip. Both models incorporate a safety feature providing for operation of relay in case of current or electron tube failure. Relay connections of Types P15NHX and P15NLX are those of a s-p.d.t. switch. Relay contacts are rated at 1000 watts a.c. and may operate lights, lamp motors, etc. When Type P15NHX is used to control level of any conductive liquid, such as water or acids, in tanks of gasoline, oil, or similar non-conductive materials, control remains inoperative while probe is immersed in the non-conductor, but when the conductive liquid rises to probe tip, relay operates. Types P15NHX and P15NLX are available for operation on 230, 208 or 115 volts a.c. 60 cycles.—*Photoswitch, Inc., 21 Chestnut St., Cambridge, Mass.*



Aircraft Spark Plug Tester

Purpose of new "Model HSPT3 HydrOILic" spark plug tester is to test the firing precisions of aircraft spark plugs. It develops air pressure up to 750 lbs./in.² within 15 seconds and maintains that pressure for at least a minute. Testing time averages 30 seconds per plug. To operate, a plug is seated in an adapter, and action of the "HydrOILic" cylinder clamps the plug into an air-tight chamber. Desired voltage and pressure are selected and action of plug indicated. Stand consists of a steel frame mounted on swivel casters and equipped with start-stop push buttons, high- and low-pressure air gages, low-pressure needle valve, adapters, oil level gage, high-voltage connector, low-voltage terminal and operating levers. Safety features: (1) operator is forced to move two levers—one with each hand—in opening or closing clamping mechanism; (2) circuit to spark plugs is completed only after plug is clamped into position and is



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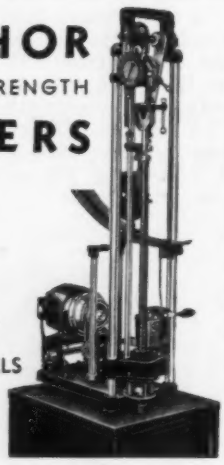

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MICROMETERS (POCKET and DESK)
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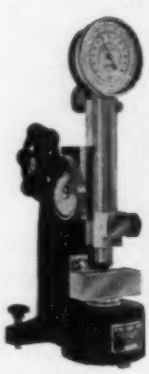

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automatically broken when clamp is released: operator may handle the plug in complete safety. — *Dennison Engineering Co., 100 W. Chestnut St., Columbus, Ohio.*

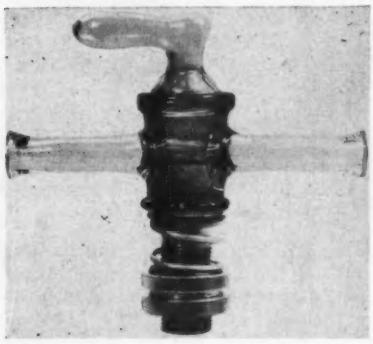
Photoelectric Relays and Light Sources

Outstanding feature of new "Series 70 Controls" is flexibility of adaptation to wide variety of industrial applications. This was principal reason for their addition to maker's already-ex-

tensive line. There are four models of photoelectric relays. "No. 74 Control" (shown at left) operates on 0.5 ft.-candle minimum, has a contact capacity of 3 amps, weighs 11 lbs. "Model 76" (not shown) incorporates a 2-tube amplifier and is designed for high sensitivity. Infra-red filters are available. "No. 72" uses an RCA Type 923 phototube, the three other models use an RCA Type 921. All four operate on 110-volt 60-cycle a-c. supply. There are two types of light sources, one without transformer (connected to the control unit), the other operating from 110-volt 60-cycle supply and having transformer taps for various light intensities. — *United Cinephone Corp., Torrington, Conn.*

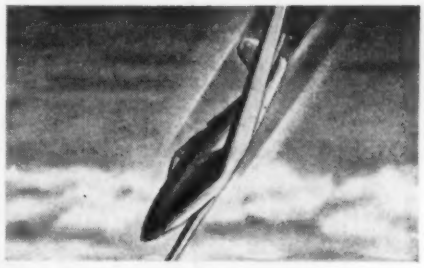
Spring-loaded Stopcock

New spring-loaded stopcock is made of Pyrex, is available in ¼", ½" and ¾" sizes. Spring loading prevents plug from blowing out under pressure. De-

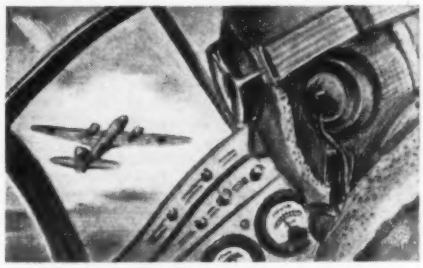


vice is good for pressures up to 100 lbs. Spring is chosen for the pressure that the cock is expected to stand. If plug freezes, lock nuts on spring may be loosened and plug tapped free without danger of it blowing out of the line.— *Fischer & Porter Co., Hatboro, Pa.*

Wonderful things! ...Instruments



They go through thick and thin with our pilots.



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HERE is a practical reference book for all concerned with instrument and control problems in industry. Fully covers in a theoretical and practical way the measurement and control of temperature, pressure, fluid flow and liquid level. Automatically controlled continuous processes are thoroughly analyzed and practical rules established for the design and maintenance of controlling instruments. The book supplies the data called for by the enormous increase in the number of instruments and controls used in industry, together with the increased complexity of the problems attending their design, installation, and maintenance.

Practical facts on:

—all types of pressure-measuring instruments;

—indicating and recording thermometers;

—design and construction of thermocouples;

—design and construction of radiation pyrometers;

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—liquid-level measurement by means of float gauge instruments;

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—etc., etc.

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In. 4-43

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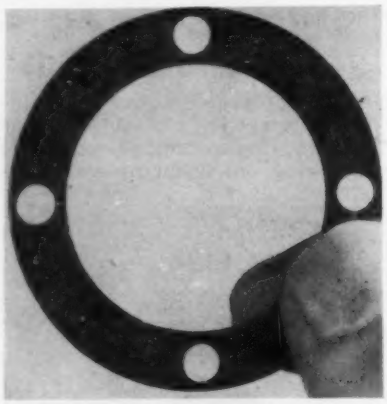
New "Model 461 Uultrasensitive Multitester" has a sensitivity of 20,000 ohms per volt on all d-c. scales, resulting in negligible loading on delicate circuits. The sensitivity on a-c. scales is 1,000 ohms per volt. Long scale on

the 4½″ indicator make for easy reading: measurements as low as 1 microampere are possible on the 100-ma. scale. Shunts and matched pair metalized voltage multipliers are accurate to within 1%. A suppressor type copper oxide rectifier is employed. Twenty-six ranges cover a-c. and d-c. volts to 5000, micro- and milliamperes, resistance and decibels. Overall dimensions 7″ × 5½″ × 3″. Tester is supplied with self-contained battery supply and leather handle; also available in hinged-cover portable case with accessory compartment and test leads.—*Radio City Products Co. Inc., 127 W. 26th St., New York City.*

Composition Gaskets

New composition gaskets for "electrical, fuel and all types of pressure gages" are characterized by close tolerances. Gasket illustrated here (actual



size) is for a fuel pressure instrument. Its specifications call for tolerances of ±0.001″ in the I.D. and O.D. and dividing circle of the holes to 15-30 minutes. Taper is held within ±0.003. Composition is synthetic rubber and cork.—*Aircraft Specialties Co., 16 Sunrise Highway, Baldwin, N. Y.*

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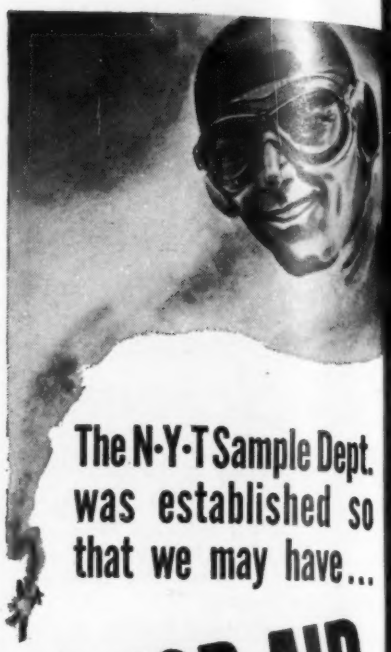

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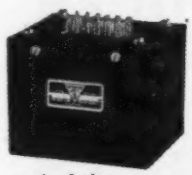

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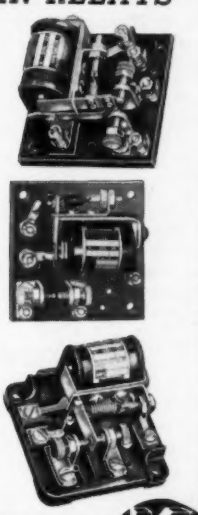

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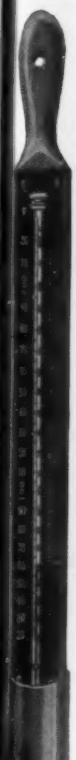

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Instrument Societies

CHICAGO

At the March meeting, Dr. H. A. Leedy, Physicist in Acoustics at the Armour Research Foundation, discussed measurements of sound and vibrations, and the utilization of such measurements in reducing noise.

Various types of sound-meters and sound analyzers, both indicating and recording, were described by Dr. Leedy, and the characteristics of each were explained. Applications were illustrated by outstanding examples, such as measurements of traffic and street noises to detect and correct flagrant sources, improvement of acoustical conditions by recording the rate of dampening a standard sound impulse, and equipment developed at the Foundation for measuring sound-insulating or reflecting properties of wall and ceiling materials.

Dr. Leedy's slides included graphs of normal perception and reaction ranges in frequencies and intensities, records taken from various analyzers, and pictures and operating diagrams of instruments.

Dr. Leedy then described the methods of measuring and analyzing vibration displacement, velocity and acceleration.

—HUGH E. FERGUSON

NEWARK (by telegram)

More than forty attended April 6 meeting. Instructive talk on time sequence control by Whiddett of Automatic Temperature Control Co.

—BOB GRAY

PHILADELPHIA

At the March 17th meeting, M. H. White, General Foreman of the Atlantic Refining Co., discussed "Instrument Maintenance in an Oil Refinery". He described the maintenance organization of a refinery with approximately 8000 instruments, excluding pressure gages. Greatest factor toward successful operation, he said, was the plant instrument apprentice school which was organized in 1928. The course covers a four year period in mechanics, electricity, flow meter theory, and control theory. It has paid real dividends in these days of green outside help.

Dinner attendance was 40, with 74 at the meeting.

—GEORGE HAMMER

EASTERN PHOTOELASTICITY CONFERENCE

The Seventeenth Semi-annual Meeting of the Eastern Photoelasticity Conference and Symposium on Experimental Stress Analysis will be held on May 13, 14, and 15, at the Rackham Memorial Bldg., 100 Farnsworth St., Detroit, Mich., under the auspices of the Chrysler Institute of Engineering.

Inquiries should be addressed to: Eastern Photoelasticity Conference and Symposium on Experimental Stress Analysis, Chrysler Institute of Engineering, Highland Park, Mich.

—LEE R. BAKER

INSTRUMENT SOCIETIES CALENDAR

City, Society and Secretary			Date	Place	Subject	Speaker
Atlanta	Georgia Society for Measurement & Control	D. D. Beach, P.O. Box 4569, Atlanta, Ga.				
Baltimore	Baltimore Industrial Instrumentation Society	Fred Pullen, Bethlehem Steel Co., Sparrows Point, Md.				
Chicago	Chicago Society for Measurement & Control	Carl Hope, 2626 W. 31st Blvd., Chicago	May 3(B)	St. Clair Hotel	Substitutes for materials used in instrumentation	H. C. Dickinson, General Electric Co.
Hartford	Hartford Society for Measurement & Control	Stephen J. Zelle, Whitney Chain & Mfg. Co., Hartford, Conn.	May 18(D)	Hartford Electric Light Auditorium	Precision measurements with the use of optics	C. B. McCathron, Bausch & Lomb Optical Co.
Newark	New Jersey Society for Measurement & Control	R. F. Robey, 409 Orange Ave., Cranford, N. J.	May 4(C)	Public Service Terminal Restaurant	Conductivity measurement and control in industry	Nathan Schnoll, Pres. Industrial Instruments, Inc.
New York	New York Society for Measurement & Control	R. K. Farnham, 545 Fifth Ave., N. Y. C.	Apr. 27(B)	Churchill's Terminal Restaurant	Magnetic circuits for instruments and control devices	H. C. Roters, Dir. Research Fairchild Aviation Corp.
			May 25(B)	Churchill's Terminal Restaurant	Special Instruments in the War	R. J. S. Pigott, Chief Engr. Gulf Research & Dev. Corp.
Philadelphia	Philadelphia Society for Instrumentation	George Hammer, Foxboro Co., 701 Otis Bldg., Phila., Pa.	May 19(B)	Engineer's Club	The relay as an instrument auxiliary	C. A. Packard, Mgr. Field Eng., Struthers Dunn, Inc.
Pittsburgh	American Society for Measurement & Control	L. M. Susany, c/o Carnegie Institute, 4400 Forbes St., Pgh.				

(A)Meeting at 7:30, no dinner. (B)Dinner at 6:30, meeting at 8. (C)Dinner at 7, meeting at 8. (D)Meeting at 8, no dinner.

Electrical Instruments Standardized

Continued from Page 222

made through a microscope of 40 to 100 diameters magnification."

(2) "Number of Readings—Qualification Tests.—at least 10 readings shall be taken and compared with corresponding readings on the laboratory standard."

"PACKAGING, PACKING, AND MARKING" and "REQUIREMENTS APPLICABLE TO INDIVIDUAL GOVERNMENT DEPARTMENTS" are the titles of the next two sections, which need not be summarized.

"NOTES"

This is a miscellaneous section. It begins with Information Required on Orders but includes technical notes, too, of which here is a sample quoted word for word:

"It is not considered good practice to mount equipment on instrument studs. In no case should equipment weighing in excess of one ounce be mounted on studs."

DRAWINGS

After a one-page Appendix which lists special instruments, and preceding the Index which concludes the document, there are 19 pages of drawings. These include, in addition to dimensional specifications, tables of data such as type and range designations and characteristics.

American Standards Association:

DRAWING	TITLE
C39.2-1A	Dimensions for 2½-inch Instruments
C39.2-2A	Dimensions for 3½-inch Instruments
C39.2-3A	Form of Letters and Figures
	Ranges and Type Designations for 2½-inch Instruments
C39.2-4A	Direct-current Voltmeters
C39.2-5A	Direct-current Milliammeters and Microammeters
C39.2-6A	Direct-current Ammeters
C39.2-7A	Alternating-current Voltmeters
C39.2-8A	Alternating-current Milliammeters and Ammeters
C39.2-9A	Radio-frequency Milliammeters and Ammeters
	Ranges and Type Designations for 3½-inch Instruments
C39.2-10A	Direct-current Voltmeters
C39.2-11A	Direct-current Milliammeters and Microammeters
C39.2-12A	Direct-current Ammeters
C39.2-13A	Alternating-current Voltmeters
C39.2-14A	Alternating-current Milliammeters and Ammeters
C39.2-15A	Radio-frequency Milliammeters and Ammeters
	Special Instruments
C39.2-16A	Type Designations and Characteristics of Power-level Indicators
C39.2-17A	Type Designations and Characteristics or Volume-level Indicators
C39.2-18A	Direct-current Instruments
C39.2-19A	Alternating-current Instruments

Manufacturers' New Literature

In this department we report ALL pieces of new literature pertaining to Instrumentation, received from the manufacturers. To assist in the War Effort we urge readers to request ONLY those bulletins which will be of value to them. Use the coupon on this page.

K-118 **Welder Timing Control.** Leaflet, 8½″ × 11″, 2 pages, illustrates the Series A welder timers designed to afford the same precision of timing for small welders as generally obtains on larger welders. Electronic Products Co., 9 N. First St., Geneva, Ill.

K-119 **Relays.** Bulletin 20, 8½″ × 11″, 2 pages, describes a mechanical latching double coil relay which is claimed to meet all the requirements in the field of automatic and supervisory control. Control Corp., 600 Stinson Blvd., Minneapolis, Minn.

K-120 **High Frequency Heating.** Bulletin, 8½″ × 11″, 18 pages, describes induction heating equipment for hardening, annealing, brazing, soldering and melting. Lepel High Frequency Labs., Inc., 39 W. 60 St., New York, N. Y.

K-121 **Proportioning Equipment for Acids, corrosive liquids and other clear solutions.** Bulletin 4009, 8½″ × 11″, 8 pages, describes proportioning equipment of the double displacement type, which eliminates pumps, moving parts, etc. It is simple in construction and depends upon the proportioning of one fluid to another by utilization of the pressure loss through the metering element, such as an orifice or Venturi tube. Cochrane Corp., 17th & Allegheny Ave., Philadelphia, Pa.

K-122 **Multi-Contact Timers.** Bulletin 3000, 8½″ × 11″, 4 pages, covers timers designed to automatically control a sequence of on and off operations of a single or a multiple number of electrical circuits in accordance with a predetermined operating program. R. W. Cramer Co., Inc., Centerbrook, Conn.

K-123 **Dyeing Quality improved with Control Equipment.** Bulletin 567 covers the use of Bristol instruments in textile plants. Bristol Co., Waterbury, Conn.

K-124 **Precision Gage Blocks.** Bulletin, 8½″ × 11″, illustrates several different sets of gage blocks for standard inspection uses as well as in the tool room and small production shop. Webber Gage Co., 12900 Triskett Road, Cleveland, O.

K-125 **Portable Electrical Instruments.** Bulletin GEA-1784C, 8″ × 10″, 44 pages, covers a-c. and d-c. portable instruments; voltmeters; ammeters; milliammeters; millivoltmeters; single-phase wattmeters; microammeters; polyphase wattmeters; power-factor meters; frequency meters; thermocouple voltmeters, ammeters and milliammeters, flux voltmeters. Complete marking information is given. General Electric Co., Schenectady, N. Y.

K-126 **Ohmite News.** The March issue of this house organ describes the Ohm's law calculator. Another article covers the calculation of voltage divider circuits. Ohmite Mfg. Co., 4835 Flournoy St., Chicago, Ill.

K-127 **Stroboscopic Techniques.** Form 597-A, 6″ × 9″, 26 pages, discusses the operation and types of stroboscopes. Sections cover qualitative and quantitative measurements; typical uses; operating hints and techniques; and photography. Various models are illustrated. General Radio Co., 30 State St., Cambridge, Mass.

K-128 **Thermal — Sub-Zero — Stratosphere Processing and Testing Machines.** Catalog 431, 8½″ × 11″, 36 pages, is divided into 2 parts. The first section covers the various processes employed in industry in utilizing ranges of temperatures and pressures. The second section deals with the machines for providing these temperature and pressure ranges. Kold-Hold Manufacturing Co., Lansing, Mich.

K-129 **Nozzle Tester for Diesel Engines.** Bulletin, 8½″ × 11″, 8 pages, describes a device for testing fuel injectors and other hydraulic devices at pressures up to 10,000 lbs./in.^{2}. This device is easy to use and makes testing a routine service job, as simple as checking a spark plug. Aircraft & Diesel Equipment Corp., 4405 N. Ravenswood Ave., Chicago, Ill.

K-130 **Remote Controls.** Catalog, loose-leaf, 8½″ × 11″, 16 pages, illustrates and describes various types of remote controls developed to meet every control requirement, includes rigid and flexible types, locking controls, vernier adjustment controls, and an improved type piano wire control. Arens Controls, Inc., 2253 S. Halsted St., Chicago, Ill.

K-131 **Glass Ground Joints.** Bulletin 42-GJ, 8½″ × 11″, 4 pages, lists and illustrates many standard taper interchangeable ground joints. These joints are made of pyrex, lime glass, quartz or nonex. Greiner Glass Blowing Lab., 255 W. Santa Barbara, Los Angeles, Calif.

K-132 **Pneumatic Telemetering.** Bulletin 513, 8½″ × 11″, 4 pages, describes a system in which air is used throughout for power which makes it particularly well suited for use in plants where explosive fumes are present. Permits distant measuremtnt of temperature, flow, pressure and liquid level. Bristol Co., Waterbury, Conn.

K-133 **Thermocouples.** Catalog No. 3, 8½″ × 11″, lists a number of base and rare metal couples, protection tubes, lead wires, insulators, and accessories. Arklay S. Richards Co., Inc., 52 Winchester St., Newton Highlands, Mass.

K-134 **Capacitors in Control Circuits.** This is the feature article in the August 1942 issue of The Aerovox Research Worker. Aerovox Corp., New Bedford, Mass.

K-135 **Electronic Switches.** Specification Sheet D, 8½″ × 11″, 2 pages, describes a switch for pressureless limit switching and floatless control of liquid levels to eliminate contact arcs and welds. United Cinephone Corp., Torrington, Conn.

K-136 **Midget Relays.** Sheet, 8½″ × 11″, 2 pages, illustrates a number of relays originally manufactured to specifications of the U. S. Army Signal Corps. Guardian Electric, 1615 W. Walnut St., Chicago, Ill.

K-137 **Coke Plant Instruments.** Bulletin No. DM004, 8½″ × 11″, 4 pages,

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reproduces diagrams showing instrument applications in coke plants. Bristol Co., Waterbury, Conn.

K-138 **Crystal Test Unit.** Sheet, 8½" × 11", 2 pages, describes a special test unit for testing radio crystals. This unit tests 336 crystals at each loading of the chamber over a temperature range from –35° to +55°C.

K-139 **Radio and Electronic Catalog.** Catalog 110, 6" × 9", 96 pages, lists everything in radio and electronics, in the Armed forces, industry and the home. Allied Radio, 833 W. Jackson Blvd., Chicago, Ill.

K-140 **Frequency Meter.** Bulletin 108, 8½" × 11", 1 page, lists the characteristics of the Type S-2 frequency meter having, it is claimed, an accuracy of better than .005%. The circuit design and operation is also described. Browning Labs., Inc., Winchester, Mass.

K-141 **Radio Parts and Accessories.** Catalog, 8½" × 11", 16 pages, describes and lists standard parts carried in stock and intended for the amateur and experimenter: 50-watt transmitter exciter; transmitting condensers; dials, drives, scales and knobs; transmitting coils, forms, neutralizing condensers; receiving condensers, flexible couplings; tuned exciter tanks, RF chokes, shields; standoffs, coil forms; safety terminals, connectors, sockets; antenna devices, safety relays; prewired foundation units, chassis, panels; IF transformers, wave traps, hash filters; frequency standards and midget frequency meters. James Miller Mfg. Co., Inc., Malden, Mass.

K-142 **Instrument Cleaning Compound.** Bulletin PIA, leaflet size, announces new visual-indicating instrument cleaning compound, illustrates color change from blue (active) to red (used out), gives technical data on most effective and economical use. The Odell Co., Inc., 230 Wright St., Newark, N. J.

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Air Express Div., Railway Express Agency A11
Alden Products Co., Inc. 223
American Coils Company 232
American Cystoscope Makers, Inc. 214
Ames Company, B. C. 215
Amthor Testing Instrument Co., Inc. 242
Arnold Engineering Company, The 207
Automatic Electric Mfg. Company 228
Bailey Meter Company 230
Baily Vibrator Company 229
Barber-Colman Company 228
Bar-Ray Products, Inc. 245
Bendix Aviation Corporation 199, 207
Biddle Company, James G. A9
Boes Company, The W. W. 243
Breeze Corporations, Inc. 203
Chace Company, W. M. 229
Cinaudagraph Corporation 241
Clarostat Manufacturing Co., Inc. 224
Cochrane Corporation A7
Commercial Engineering Laboratories 231
Connecticut Telephone & Electric Division 211
Connelly Iron Sponge & Governor Co. 234
Cramer Company, Inc., The R. W. 226
Daven Company, The ..... Inside Back Cover
Dejur-Amsco Corporation A6
Du Mont Laboratories, Inc., Allen B. 233
Eppley Laboratory, Inc., The 218
Executone, Inc. 227
Federal Products Corporation 214
Federal Tool Corporation 214
Fenwal Incorporated 229
Fischer & Porter Company A4
Fulton Sylphon Company 193
Gaertner Scientific Corp., The 209
General Radio Company A5
Gorrell & Gorrell 248
Gothard Manufacturing Company 208
Great American Industries, Inc. 211
Grove Regulator Company 219
Guardian Electric 221
Hathaway Instrument Company, The 237
Hays Corporation, The 227
H-B Instrument Company, Inc. 245
Heise Bourdon Tube Laboratories 219
Hewlett-Packard Company A10
Hickok Electrical Instrument Co., The 235
Hopp Press, Inc., The 226
Illinois Testing Laboratories, Inc. 222
I-T-E Circuit Breaker Company 241
Jones-Motrola Sales Company 240
Kester Solder Company 210
Kollsman Instrument Division 196
Kurman Electric Company, Inc. 245
Leeds & Northrup Company A12
Liquidometer Corporation 222
Littelfuse Incorporated 228
L & R Manufacturing Company 206
Luminous Engineering Company 216
Marine Division, Bendix Aviation Corp. 207
Marshall Company, C. & E. A1
McGraw-Hill Book Company 244
Measurements Corporation ..... Back Cover
Meriam Company, The 205
Mobile Refrigeration, Inc. 201
Moeller Instrument Company 227
Naxon Utilities Corporation 215
New York Transformer Company 244
Odell Company, Inc. 191
Ohmite Manufacturing Company 225
Oster Mfg. Co. of Illinois, John A8
Palmer Company, The 236
Paraloy Company, The 218
Permo Products Corporation 226
Philadelphia Thermometer Co., The 239
Photovolt Corporation 236
Pioneer Instrument Div., Bendix Aviation Corp. 199
Precision Thermometer & Instrument Co. 209
Railway Express Agency, Air Express Div. A11
Rawson Electrical Instrument Co. 226
Rubicon Company 241
Selenium Corp. of America 223
Shallcross Manufacturing Company 223
Shore Instrument & Mfg. Co., Inc. 242
Silk Screen Supplies, Inc. 243
Simplex Valve & Meter Company 204
Simpson Optical Mfg. Company 202
Sola Electric Company 213
SpeedWay Manufacturing Co. 246
Spencer Lens Company 212
Square D Company 196
Standard Electric Time Co., The 221
Sticht Co., Inc., Herman H. 234
Stokes Machine Company, F. J. 238
Sturtevant Company, P. A. 236
Tagliabue Mfg. Co., C. J. ..... Inside Front Cover
Taylor Instrument Companies A3
Tenney Engineering, Inc. 209
Trimount Instrument Company 243
Triplett Electrical Instrument Co. 239
Uniform Tubes 206
United Transformer Company 220
Ward Leonard Electric Company 208
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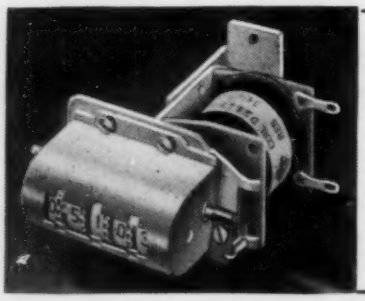

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